

APPENDIX F.1

ESSENTIAL FISH HABITAT ASSESSMENT REPORT

for the Groundfish Resources of the

Gulf of Alaska Region

August 22, 2003

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Table of Contents

Introduction	F.1-1
Table 1- Summary of Major References and Atlases	F.1-3
Table 2 - Summary of Habitat Associations for Groundfish in the GOA	F.1-5
Table 3 - Summary of Reproductive Traits for Groundfish in the GOA	F.1-8
Table 4 - Summary of Predator and Prey Associations for Groundfish in the GOA	F.1-9
Habitat Description for Walleye pollock	F.1-12
Habitat Description for Pacific cod	F.1-20
Habitat Description for Dover Sole	F.1-24
Habitat Description for Greenland Turbot	F.1-27
Habitat Description for Rock Sole	F.1-31
Habitat Description for Yellowfin sole	F.1-35
Habitat Description for Rex Sole	F.1-38
Habitat Description for Flathead Sole	F.1-41
Habitat Description for Arrowtooth Flounder	F.1-44
Habitat Description for Sablefish	F.1-47
Habitat Description for Pacific Ocean Perch	F.1-51
Habitat Description for Shortraker Rockfish and Rougheye Rockfish	F.1-57
Habitat Description for Northern Rockfish	F.1-61
Habitat Description for Light Dusky Rockfish	F.1-65
Habitat Description for Yelloweye Rockfish	F.1-69
Habitat Description for Thornyhead Rockfish	F.1-73
Habitat Description for Atka mackerel	F.1-77
Habitat Description for Capelin	F.1-81

Habitat Description for Habitat Description for Eulachon	F.1-85
Habitat Description for Sculpins	F.1-89
Habitat Description for Sharks	F.1-93
Habitat Description for Skates	F.1-96
Habitat Description for Squid	F.1-99
Habitat Description for Octopus	F.1-103

Introduction

In 1996, the Sustainable Fisheries Act amended the Magnuson-Stevens Fishery Conservation and Management Act to require the description and identification of Essential Fish Habitat (EFH) in Fishery Management Plans (FMPs), adverse impacts on EFH, and actions to conserve and enhance EFH. Guidelines were developed by the National Marine Fisheries Service (NMFS) to assist Fishery Management Councils in fulfilling the requirements set forth by the Act.

Essential fish habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat: “waters” includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means the habitat required to support a sustainable fishery and a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species’ full life cycle.

With respect to type, the information available for almost all species is primarily broad geographic distributions based on specific samples from surveys and fisheries, which have not been linked with habitat characteristics. Furthermore, our ability to precisely define the habitat (and its location) of each life stage of each managed groundfish species in terms of its oceanographic (temperature, salinity, nutrient, current), trophic (presence of food, absence of predators), and physical (depth, substrate, latitude, and longitude) characteristics is very limited. Consequently, the information included in the habitat descriptions for each species and life stage is restricted primarily to their position in the water column (e.g., demersal, pelagic), broad biogeographic and bathymetric areas (e.g., 100-200 m zone, south of the Pribilof Islands and throughout the Aleutian Islands), and occasional references to known bottom types associations.

Identification of EFH for some species included historical range information. Traditional knowledge and sampling data have indicated that fish distributions may contract and expand due to a variety of factors including, but not limited to, temperature changes, current patterns, changes in population size, and changes in predator and prey distribution.

Background

In preparation of the 1999 Essential Fish Habitat Environmental Assessment, EFH Technical Teams, comprised of scientific stock assessment authors, compiled scientific information and prepared the 1999 Habitat Assessment Reports. These reports provided the scientific information baseline to describe EFH. Importantly, recent scientific evidence has not proved to change existing life history profiles of the federally managed species. However, where new information does exist, new data helps to fill information gaps in the region’s limited habitat data environment.

Stock assessment authors used information contained in these summaries and personal knowledge, along with data contained in reference atlases (NOAA 1987; 1990; NPFMC 1997a;b), fishery and survey data (Allen and Smith 1988; Wolotira et al. 1993; NOAA 1998), and fish identification books (Hart 1973; Eschmeyer and Herald 1983; Mecklenburg and Thorsteinson 2002), to describe EFH for each life stage using best scientific judgment and interpretation; see Table 1.

Species Profiles and Habitat Descriptions

FMPs must describe EFH in text, map EFH distributions, and include tables, which provide information on habitat and biological requirements for each life history stage of the species; see Tables 2-4. Information contained in this report details life history information for federally managed fish species. This collection of scientific information is interpreted, then referenced to describe and delineate EFH for each species by life history stage using GIS. EFH text and map descriptions are not compiled in this report due to differences in the characteristics of a species life history and the overall distribution of the species. Specific EFH text descriptions and maps are in Appendix D.

References

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Table 1. Summary of Major References and Atlases

Species	References					
	Allen and Smith 1988	NOAA 1987	NOAA 1990	Wolotira et al. 1993	NOAA 1998	Mecklenburg and Thorsteinson 2002
Walleye pollock	X	X	X	X	X	X
Pacific cod	X	X	X	X	X	X
Yellowfin sole	X	X		X	X	X
Greenland turbot	X	X		X	X	X
Arrowtooth flounder	X	X	X	X	X	X
Rock sole	X	X		X	X	X
Alaska plaice	X	X		X	X	X
Flathead sole	X	X	X	X	X	X
Sablefish	X		X	X	X	X
Pacific ocean perch	X		X	X	X	X
Shortraker-rougheye rockfish	X				X	X
Northern rockfish	X				X	X
Dusky rockfish	X				X	X
Thornyhead rockfish	X				X	X
Atka mackerel	X		X	X	X	X
Sculpins	X				X	X
Skates	X				X	X

Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features.

Location

ICS = inner continental shelf (1-50 m)	USP = upper slope (200-1000 m)
MCS = middle continental shelf (50-100 m)	LSP = lower slope (1000-3000 m)
OCS = outer continental shelf (100-200 m)	BSN = basin (>3000 m)

BCH = beach (intertidal)

BAY = nearshore bays, give depth if appropriate (e.g., fjords)

IP = island passes (areas of high current), give depth if appropriate

Water column

D = demersal (found on bottom)

SD/SP = semi-demersal or semi-pelagic if slightly greater or less than 50% on or off bottom

P = pelagic (found off bottom, not necessarily associated with a particular bottom type)

N = neustonic (found near surface)

Bottom Type

M = mud S = sand R = rock

SM = sandy mud CB = cobble C = coral

MS = muddy sand G = gravel K = kelp

SAV = subaquatic vegetation (e.g., eelgrass, not kelp)

Oceanographic Features

UP = upwelling G = gyres F = fronts E = edges

CL = thermocline or pycnocline

General

U = Unknown N/A = not applicable

Appendix F
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Table 2 - Habitat

Table 2. Summary of Habitat Associations for Groundfish in the GOA

[illegible]

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[illegible]

Table 3. Summary of Reproductive Traits for Groundfish in the GOA

GOA Groundfish		Reproductive Traits																										
		Age at Maturity				Fertilization/Egg Development					Spawning Behavior						Spawning Season											
		Female		Male																								
Species	Life Stage	50%	100%	50%	100%	External	Internal	Oviparous	Ovoviparous	Viviparous	Batch Spawner	Broadcast Spawner	Egg Case Deposition	Nest Builder	Egg/Young Guarder	Egg/Young Bearer	January	February	March	April	May	June	July	August	September	October	November	December
Walleye Pollock	M	4-5		4-5		x						x						x	x	x	x							
Pacific Cod	M	5		5		x						x					x	x	x	x	x							
Atka Mackerel	M	3.6		3.6		x								x	x						x	x	x	x	x	x		
Sablefish	M					x						x					x	x	x	x	x							
Pacific Ocean Perch	M	10.5					x			x	x														x	x	x	x
Flathead Sole	M	10				x											x	x	x	x								x
Yellowfin Sole	M	10.5				x					x										x	x	x					
Arrowtooth Flounder	M	5		4		x											x	x	x	x							x	x
Rock Sole	M	9				x					x						x	x	x									
Rex Sole	M	24cm		16cm		x												x	x	x	x	x	x					
Greenland Turbot	M	5-10				x											x	x	x							x	x	x
Dover Sole	M	33cm				x											x	x	x	x	x	x	x	x				
Yelloweye Rockfish	M	22							x											x	x	x	x					
Shortraker/Rougheye Rockfish	M	20+					x			x	x												x	x	x	x	x	x
Northern Rockfish	M	13					x			x	x																	
Thornyhead Rockfish	M	12									x							x				x						
Dusky Rockfish	M	11					x			x	x																	
Sculpins	M					x									x													
Skates	M						x	x					x															
Sharks	M						x	x	x	x			x			x												
Squid	M						x				x																	
Octopus	M						x				x			x	x													
Eulachon	M	3	5	3	5	X		X			X									X	X	X						
Capelin	M	2	4	2	4	X		X			X										X	X	X	X				
Sand Lance	M	1	2	1	2	X		X			X						X	X									X	X

Table 4. Summary of Predator and Prey Associations for Groundfish in the GOA

[illegible]

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[illegible]

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[illegible]

Habitat Description for Walleye pollock

(Theragra calcogramma)

Management Plan and Area GOA

The Gulf of Alaska are managed under the Gulf of Alaska Groundfish Fisheries Management Plan and the Eastern Bering Sea and Aleutian Islands pollock stocks are managed under the Eastern Bering Sea and Aleutian Islands Groundfish Fisheries Management Plan. Pollock occur throughout the area covered by the FMP and straddle into the Canadian and Russian EEZ, international waters of the central Bering Sea, and into the Chukchi Sea.

Life History and General Distribution

Pollock is the most abundant species within the eastern Bering Sea comprising 75-80% of the catch and 60% of the biomass. In the Gulf of Alaska, pollock is the second most abundant groundfish stock comprising 25-50% of the catch and 20% of the biomass.

Four stocks of pollock are recognized for management purposes: Gulf of Alaska, eastern Bering Sea, Aleutian Islands, and Aleutian Basin. There appears to be a high degree of interrelationship among the eastern Bering Sea, Aleutian Islands, and Aleutian Basin stocks with suggestions of movement from one area to the others. There appears to be stock separation between the Gulf of Alaska stocks and stocks to the north.

The most abundant stock of pollock is the eastern Bering Sea stock which is primarily distributed over the eastern Bering Sea outer continental shelf between approximately 70-200 m. Information on pollock distribution in the eastern Bering Sea comes from commercial fishing locations, annual bottom trawl surveys and triennial acoustic surveys.

The Aleutian Islands stock extends through the Aleutian Islands from 170E W to the end of the Aleutian Islands (Attu Island), with the greatest abundance in the eastern Aleutians (170E W to Seguam Pass). Most of the information on pollock distribution in the Aleutian Islands comes from triennial bottom trawl surveys. These surveys indicate that pollock are primarily located on the Bering Sea side of the Aleutian Islands, and have a spotty distribution throughout the Aleutian Islands chain. The bottom trawl data may not provide an accurate view of pollock distribution because a significant portion of the pollock biomass is likely to be unavailable to bottom trawls. Also, many areas of the Aleutian Islands shelf are untrawlable due to rough bottom.

The third stock, Aleutian Basin, appears to be distributed throughout the Aleutian Basin which encompasses the U.S. EEZ, Russian EEZ, and international waters in the central Bering Sea. This stock appears to move throughout the Basin for feeding, but concentrate in deepwater near the continental shelf for spawning. The principal spawning location is near Bogoslof Island in the eastern Aleutian Islands, but data from pollock fisheries in the first quarter of the year indicate that there are other concentrations of deepwater spawning concentrations in the western Aleutian Islands. The Aleutian Basin spawning stock appears to be derived from migrants from the eastern Bering Sea shelf stock, and possibly some western Bering Sea pollock. Recruitment to the stock occurs generally around age 5, very few pollock younger than age 5 have been found in the Aleutian Basin. Most of the pollock in the Aleutian Basin appear to originate from strong year classes.

The Gulf of Alaska stock extends from southeast Alaska to the Aleutian Islands (170E W), with the greatest abundance in the western and central regulatory areas (147E W to 170E W). Most of the information on

pollock distribution in the Gulf of Alaska comes from triennial bottom trawl surveys. These surveys indicate that pollock are distributed throughout the shelf regions of the Gulf of Alaska at depths less than 300 m. The bottom trawl data may not provide an accurate view of pollock distribution because a significant portion of the pollock biomass may be pelagic and not available to bottom trawls. The principal spawning location is in Shelikof Strait, but data from pollock fisheries and exploratory surveys indicate that there are other concentrations of spawning in the Shumagin Islands, the east side of Kodiak Island and near Prince William Sound.

Peak pollock spawning occurs on the southeastern Bering Sea and eastern Aleutian Islands along the outer continental shelf around mid-March. North of the Pribilof Islands spawning occurs later (April-May) in smaller spawning aggregations. The deep spawning pollock of the Aleutian Basin appear to spawn slightly earlier, late February-early March. In the Gulf of Alaska, peak spawning occurs in late March in Shelikof Strait. Peak spawning in the Shumagin area appears to 2-3 weeks earlier than in Shelikof Strait.

Spawning occurs in the pelagic zone and eggs develop throughout the water column (70-80 m in the Bering Sea shelf, 150-200 m in Shelikof Strait). Development is dependent on water temperature. In the Bering Sea, eggs take about 17-20 days to develop at 4 degrees in the Bogoslof area and 25.5 days at 2 degrees on the shelf. In the Gulf of Alaska, development takes approximately 2 weeks at ambient temperature (5 degrees C). Larvae are also distributed in the upper water column. In the Bering Sea the larval period lasts approximately 60 days. The larvae eat progressively larger naupliar stages of copepods as they grow and then small euphausiids as they approach transformation to juveniles (~25 mm standard length). In the Gulf of Alaska, larvae are distributed in the upper 40 m of the water column and the diet is similar to Bering Sea larvae. FOCI survey data indicate larval pollock may utilize the stratified warmer upper waters of the mid-shelf to avoid predation by adult pollock which reside in the colder bottom water.

At age 1 pollock are found throughout the eastern Bering Sea both in the water column and on bottom. Age 1 pollock from strong year-classes appear to be found in great numbers on the inner shelf, and further north on the shelf than weak year classes which appear to be more concentrated on the outer continental shelf. From age 2-3 pollock are primarily pelagic and then to be most abundant on the outer and mid-shelf northwest of the Pribilof Islands. As pollock reach maturity (age 4) in the Bering Sea, they appear to move from the northwest to the southeast shelf to recruit to the adult spawning population. Strong year-classes of pollock persist in the population in significant numbers until about age 12, and very few pollock survive beyond age 16. The oldest recorded pollock was age 31.

Growth varies by area with the largest pollock occurring on the southeastern shelf. On the northwest shelf the growth rate is slower. A newly maturing pollock is around 40 cm.

Fishery

The eastern Bering Sea pollock fishery has, since 1990 been divided into two fishing periods; an "A season" occurring in January-March, and a "B season" occurring in August-October. The A season concentrates fishing effort on prespawning pollock in the southeastern Bering Sea. During the B season fishing is still primarily in the southeastern Bering Sea, but some fishing also occurs on the northwestern shelf. Also during the B season catcher processor vessels are required to fish north of 56°N latitude because the area to the south is reserved for catcher vessels delivering to shoreside processing plants on Unalaska and Akutan.

Since 1992, the Gulf of Alaska pollock TAC has been apportioned spatially and temporally to reduce impacts on Steller sea lions. Although the details of the apportionment scheme have evolved over time, the general objective is to allocate the TAC to management areas based on the distribution of surveyed biomass, and to establish three or four seasons between mid-January and autumn during which some fraction of the TAC can be taken. The Steller Sea Lion Protection Measures implemented in 2001 establish four seasons in the Central and Western GOA beginning January 20, March 10, August 25, and October 1, with 25% of the total

TAC allocated to each season. Allocations to management areas 610, 620 and 630 are based on the seasonal biomass distribution as estimated by groundfish surveys. In addition, a new harvest control rule was implemented that requires a cessation of fishing when spawning biomass declines below 20% of unfished stock biomass.

In the Gulf of Alaska approximately 90% of the pollock catch is taken using pelagic trawls. During winter, fishing effort usually targeted primarily on pre-spawning aggregations in Shelikof Strait and near the Shumagin Islands. The pollock fishery has a very low bycatch rate with discards averaging about 2% since 1998 (with the 1991-1997 average around 9%). Most of the discards in the pollock fishery are juvenile pollock, or pollock too large to fit filleting machines. In the pelagic trawl fishery the catch is almost exclusively pollock.

The eastern Bering Sea pollock fishery primarily harvests mature pollock. The age where fish are selected by the fishery roughly corresponds to the age at maturity (management guidelines are oriented towards conserving spawning biomass). Fishery selectivity increases to a maximum around age 6-8 and declines slightly. The reduced selectivity for older ages is due to pollock becoming increasingly demersal with age. Younger pollock form large schools and are semi-demersal, thereby being easier to locate by fishing vessels. Immature fish (ages 2 and 3) are usually caught in low numbers. Generally the catch of immature pollock increases when strong year-classes occur and the abundance of juveniles increase sharply. This occurred with the 1989 year-class, the second largest year-class on record. Juvenile bycatch increased sharply in 1991 and 1992 when this year-class was age 2 and 3. A secondary problem is that strong to moderate year-classes may reside in the Russian EEZ adjacent to the U. S. EEZ as juveniles. Russian catch-age data and anecdotal information suggest that juveniles may comprise a major portion of the catch. There is a potential for the Russian fishery to reduce subsequent abundance in the U. S. fishery.

The Gulf of Alaska pollock fishery also targets mature pollock. Fishery selectivity increases to a maximum around age 5-7 and then declines. In both the EBS and GOA, the selectivity pattern varies between years due to shifts in fishing strategy and changes in the availability of different age groups over time.

In response to continuing concerns over the possible impacts groundfish fisheries may have on rebuilding populations of Steller sea lions, NMFS and the NPFMC have made changes to the Atka mackerel (mackerel) and pollock fisheries in the Bering Sea/Aleutian Islands and Gulf of Alaska. These have been designed to reduce the possibility of competitive interactions with Steller sea lions. For the pollock fisheries, comparisons of seasonal fishery catch and pollock biomass distributions (from surveys) by area in the eastern Bering Sea led to the conclusion that the pollock fishery had disproportionately high seasonal harvest rates within critical habitat which *could* lead to reduced sea lion prey densities. Consequently, the management measures were designed to redistribute the fishery both temporally and spatially according to pollock biomass distributions. The underlying assumption in this approach was that the independently derived area-wide and annual exploitation rate for pollock would not reduce local prey densities for sea lions. Here we examine the temporal and spatial dispersion of the fishery to evaluate the potential effectiveness of the measures.

Three types of measures were implemented in the pollock fisheries:

- Additional pollock fishery exclusion zones around sea lion rookery or haulout sites,
- Phased-in reductions in the seasonal proportions of TAC that can be taken from critical habitat, and
- Additional seasonal TAC releases to disperse the fishery in time.

Prior to the management measures, the pollock fishery occurred in each of the three major fishery management regions of the north Pacific ocean managed by the NPFMC: the Aleutian Islands (1,001,780 km² inside the EEZ), the eastern Bering Sea (968,600 km²), and the Gulf of Alaska (1,156,100 km²). The marine portion of Steller sea lion critical habitat in Alaska west of 150°W encompasses 386,770 km² of ocean surface, or 12% of the fishery management regions.

Prior to 1999, a total of 84,100 km², or 22% of critical habitat, was closed to the pollock fishery. Most of this closure consisted of the 10 and 20 nm radius all-trawl fishery exclusion zones around sea lion rookeries (48,920 km² or 13% of critical habitat). The remainder was largely management area 518 (35,180 km², or 9% of critical habitat) which was closed pursuant to an international agreement to protect spawning stocks of central Bering Sea pollock.

In 1999, an additional 83,080 km² (21%) of critical habitat in the Aleutian Islands was closed to pollock fishing along with 43,170 km² (11%) around sea lion haulouts in the GOA and eastern Bering Sea. Consequently, a total of 210,350 km² (54%) of critical habitat was closed to the pollock fishery. The portion of critical habitat that remained open to the pollock fishery consisted primarily of the area between 10 and 20 nm from rookeries and haulouts in the GOA and parts of the eastern Bering Sea foraging area.

The Bering Sea/Aleutian Islands pollock fishery was also subject to changes in total catch and catch distribution. Disentangling the specific changes in the temporal and spatial dispersion of the EBS pollock fishery resulting from the sea lion management measures from those resulting from implementation of the 1999 American Fisheries Act (AFA) is difficult. The AFA reduced the capacity of the catcher/processor fleet and permitted the formation of cooperatives in each industry sector by 2000. Both of these changes would be expected to reduce the rate at which the catcher/processor sector (allocated 36% of the EBS pollock TAC) caught pollock beginning in 1999, and the fleet as a whole in 2000. Because of some of its provisions, the AFA gave the industry the ability to respond efficiently to changes mandated for sea lion conservation that otherwise could have been more disruptive to the industry.

In 2000, further reductions in seasonal pollock catches from BSAI sea lion critical habitat were realized by closing the entire Aleutian Islands region to pollock fishing and by phased-in reductions in the proportions of seasonal TAC that could be caught from the Sea Lion Conservation Area, an area which overlaps considerably with sea lion critical habitat. In 1998, over 22,000 t of pollock were caught in the Aleutian Island regions, with over 17,000 t caught in AI critical habitat. Since 1998 directed fishery removals of pollock have been prohibited.

Relevant Trophic Information

Juvenile pollock through newly maturing pollock primarily utilize copepods and euphausiids for food. At maturation and older ages pollock become increasingly piscivorous, with pollock (cannibalism) a major food item in the Bering Sea. Most of the pollock consumed by pollock are age 0 and 1 pollock, and recent research suggests that cannibalism can regulate year-class size. Weak year-classes appear to be those located within the range of adults, while strong year-classes are those that are transported to areas outside the range of adult abundance.

Being the dominant species in the eastern Bering Sea pollock is an important food source for other fish, marine mammals, and birds. On the Pribilof Islands hatching success and fledgling survival of marine birds has been tied to the availability of age 0 pollock to nesting birds.

Upper size limit of juvenile fish

The upper size limit for juvenile pollock in the eastern Bering Sea and Gulf of Alaska is about 38-42 cm. This is the size of 50% maturity. There is some evidence that this has changed over time.

Sources for Additional Information

Eggs and Larvae:

Jeff Napp, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA, 206-526-4148.

Shallow water concentrations:

Bill Bechtol, Alaska Department of Fish and Game, 3298 Douglas Place, Homer, Alaska 99603-8027.

Habitat and Biological Associations

Egg-Spawning: Pelagic on outer continental shelf generally over 100-200 m depth in Bering Sea. Pelagic on continental shelf over 100-200 m depth in Gulf of Alaska.

Larvae: Pelagic outer to mid-shelf region in Bering Sea. Pelagic throughout the continental shelf within the top 40 m in the Gulf of Alaska.

Juveniles: Age 0 appears to be pelagic, as is age 2 and 3. Age 1 pelagic and demersal with a widespread distribution and no known benthic habitat preference.

Adults: Adults occur both pelagically and demersally on the outer and mid-continental shelf of the Gulf of Alaska, eastern Bering Sea and Aleutian Islands. In the eastern Bering Sea few adult pollock occur in waters shallower than 70 m. Adult pollock also occur pelagically in the Aleutian Basin. Adult pollock range throughout the Bering Sea in both the U.S. and Russian waters, however, the maps provided for this document detail distributions for pollock in the U.S. Exclusive Economic Zone and the basin.

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SPECIES: Gulf of Alaska Walleye Pollock

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	14 d. at 5 C	None	Feb-Apr	OCS, UCS	P	N/A	G?	
Larvae	60 days	copepod naupli and small euphausiids	Mar-Jul	MCS, OCS	P	N/A	G? F	pollock larvae with jellyfish
Juveniles	0.4 to 4.5 years	Pelagic crustaceans, copepods and euphausiids	Aug. +	OCS, MCS, ICS	P, SD	N/A	CL, F	
Adults	4.5 - 16 years	Pelagic crustaceans and fish	Spawning Feb-Apr	OCS, BSN	P, SD	UNK	F UP	Increasingly demersal with age.

Habitat Description for Pacific cod

(Gadus macrocephalus)

Management Plan and Area GOA

Life History and General Distribution

Pacific cod is a transoceanic species, occurring at depths from shoreline to 500 m. The southern limit of the species' distribution is about 34° N latitude, with a northern limit of about 63° N latitude. Adults are demersal and form aggregations during the peak spawning season, which extends approximately from January through May. Pacific cod eggs are demersal and adhesive. Eggs hatch in about 15-20 days. Little is known about the distribution of Pacific cod larvae, which undergo metamorphosis at about 25-35 mm. Juvenile Pacific cod start appearing in trawl surveys at a fairly small size, as small as 10 cm in the eastern Bering Sea. Pacific cod can grow to be more than a meter in length, with weights in excess of 10 kg. Natural mortality is believed to be somewhere between 0.3 and 0.4. Approximately 50% of Pacific cod are mature by ages 5-6. The maximum recorded age of a Pacific cod from the Bering Sea/Aleutian Islands (BSAI) or Gulf of Alaska (GOA) is 19 years.

Fishery

The fishery is conducted with bottom trawl, longline, pot, and jig gear. The age at 50% recruitment varies between gear types and regions. In the BSAI, the age at 50% recruitment is 6 years for trawl gear, 4 years for longline and 5 years for pot gear. In the GOA, the age at 50% recruitment is 5 years for trawl gear and 6 years for longline and pot gear. More than 100 vessels participate in each of the three largest fisheries (trawl, longline, pot). The trawl fishery is typically concentrated during the first few months of the year, whereas fixed-gear fisheries may sometimes run, intermittently, at least, throughout the year. Bycatch of crab and halibut sometimes causes the Pacific cod fisheries to close prior to reaching the total allowable catch. In the BSAI, trawl fishing is concentrated immediately north of Unimak Island, whereas the longline fishery is distributed along the shelf edge to the north and west of the Pribilof Islands. In the GOA, the trawl fishery has centers of activity around the Shumagin Islands and south of Kodiak Island, while the longline fishery is located primarily in the vicinity of the Shumagins.

Relevant Trophic Information

Pacific cod are omnivorous. In terms of percent occurrence, the most important items in the diet of Pacific cod in the BSAI and GOA are polychaetes, amphipods, and crangonid shrimp. In terms of numbers of individual organisms consumed, the most important dietary items are euphausiids, miscellaneous fishes, and amphipods. In terms of weight of organisms consumed, the most important dietary items are walleye pollock, fishery discards, and yellowfin sole. Small Pacific cod feed mostly on invertebrates, while large Pacific cod are mainly piscivorous. Predators of Pacific cod include halibut, salmon shark, northern fur seals, sea lions, harbor porpoises, various whale species, and tufted puffin.

Upper size limit of juvenile fish (in cm): The estimated size at 50% maturity is 67 cm.

Source of additional information

NMFS, Alaska Fisheries Science Center, FOCI Program, Ann Matarese 206-526-4111

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Spawning takes place in the sublittoral-bathyal zone (40-290 m) near bottom. Eggs sink to the bottom after fertilization, and are somewhat adhesive. Optimal

temperature for incubation is 3-6° C, optimal salinity is 13-23 ppt, and optimal oxygen concentration is from 2-3 ppm to saturation. Little is known about the optimal substrate type for egg incubation.

Larvae: Larvae are epipelagic, occurring primarily in the upper 45 m of the water column shortly after hatching, moving downward in the water column as they grow.

Juveniles: Juveniles occur mostly over the inner continental shelf at depths of 60-150 m.

Adults: Adults occur in depths from the shoreline to 500 m. Average depth of occurrence tends to vary directly with age for at least the first few years of life, with mature fish concentrated on the outer continental shelf. Preferred substrate is soft sediment, from mud and clay to sand.

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SPECIES: Pacific cod

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	15-20 d	NA	winter-spring	ICS, MCS, OCS	D	M, SM, MS ,S	U	optimum 3-6°C optimum salinity 13-23 ppt
Larvae	U	copepods (?)	winter-spring	U	P (?), N (?)	U	U	
Early Juveniles	to 2 yrs	small invertebrates (mysids, euphausiids, shrimp)	all year	ICS, MCS	D	M, SM, MS, S	U	
Late Juveniles	to 5 yrs	pollock, flatfish, fishery discards, crab	all year	ICS, MCS, OCS	D	M, SM, MS, S	U	
Adults	5+ yr	pollock, flatfish, fishery discards, crab	spawning (Jan-May)	ICS, MCS, OCS	D	M, SM, MS, S,G	U	
			non-spawning (Jun-Dec)	ICS, MCS, OCS				

Habitat Description for Dover Sole

(Microstomus pacificus)

The deep water flatfish management complex in the Gulf of Alaska is comprised of three species, Dover sole (*Microstomus pacificus*), Greenland turbot (*Reinhardtius hippoglossoides*) and the deep sea sole (*Embassicthys bathbius*). Dover sole is the most abundant and commercially important species of this management complex in the Gulf of Alaska.

Management Plan and Area GOA

Life History and General Distribution

Dover sole are distributed in deep waters of the continental shelf and upper slope from northern Baja California to the Bering Sea and the western Aleutian Islands (Hart 1973, Miller and Lea 1972), and exhibit a widespread distribution throughout the Gulf of Alaska. Adults are demersal and are mostly found in water deeper than 300 meters. The spawning period off Oregon is reported to range from January through May (Hunter et al. 1992). Spawning in the Gulf of Alaska has been observed from January through August, with a peak period in May (Hirschberger and Smith 1983). Eggs have been collected in neuston and bongo nets in the summer, east of Kodiak Island (Kendall and Dunn 1985), but the duration of the incubation period is unknown. Larvae were captured in bongo nets only in summer over mid-shelf and slope areas (Kendall and Dunn 1985). The age or size at metamorphosis is unknown but the pelagic larval period is known to be protracted and may last as long as two years (Markle et al. 1992). Pelagic postlarvae as large as 48 mm have been reported and the young may still be pelagic at 10 cm (Hart 1973). Dover sole are batch spawners and Hunter et al. (1992) concluded that the average 1 kg. female spawns its 83,000 advanced yolked oocytes in about nine batches. Maturity studies from Oregon indicate that females were 50% mature at 33 cm total length. Juveniles less than 25 cm are rarely found with the adult population from bottom trawl surveys (Martin and Clausen 1995). The natural mortality rate used in recent stock assessments is 0.2 (Turnock et al. 2002).

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 5. They are caught as bycatch in the rex sole, thornyhead and sablefish fisheries and are caught with these species and Pacific halibut in Dover sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod and most likely arrowtooth flounder.

Approximate upper size limit of juvenile fish: 32 cm.

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for up to 2 years until metamorphosis occurs, juvenile distribution is unknown.

Adults: Winter and spring spawning and summer feeding on soft substrates (combination of sand and mud) of the continental shelf and upper slope. Shallower summer distribution mainly on the middle to outer portion of the shelf and upper slope, feeding mainly on polychaetes, annelids, crustaceans and mollusks (Livingston and Goiney 1983).

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SPECIES: Dover sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	spring summer	ICS? MCS OCS USP	P			
Larvae	up to 2 years	U phyto/zoo plankton?	all year	ICS? MCS OCS USP	P			
Early Juveniles	to 3 years	polychaetes amphipods annelids	all year	MCS? ICS?	D	S, M		
Late Juveniles	3-5 years	polychaetes amphipods annelids	all year	MCS? ICS?	D	S, M		
Adults	5+ years	polychaetes amphipods annelids mollusks	spawning Jan-August non-spawning July-January	MCS OCS USP	D	S, M		

Habitat Description for Greenland Turbot

(Reinhardtius hippoglossoides)

Management Plan and Area GOA

Life History and General Distribution

Greenland turbot has an amphiboreal distribution, occurring in the North Atlantic and North Pacific, but not in the intervening Arctic Ocean. In the North Pacific, species abundance is centered in the eastern Bering Sea and, secondly, in the Aleutians. On the Asian side, they occur in the Gulf of Anadyr along the Bering Sea coast of Russia, in the Okhotsk Sea, around the Kurile Islands, and south to the east coast of Japan to northern Honshu Island (Hubbs and Wilimovsky 1964, Mikawa 1963, Shuntov 1965). Adults exhibit a benthic lifestyle, living in deep waters of the continental slope but are known to have a tendency to feed off the sea bottom. During their first few years as immature fish, they inhabit relatively shallow continental shelf waters (<200 m) until about age 4 or 5 before joining the adult population (200 - 1,000 m or more, Templeman 1973). Adults appear to undergo seasonal shifts in depth distribution moving deeper in winter and shallower in summer (Chumakov 1970, Shuntov 1965). Spawning is reported to occur in winter in the eastern Bering Sea and may be protracted starting in September or October and continuing until March with an apparent peak period in November to February (Shuntov 1970, Bulatov 1983). Females spawn relatively small numbers of eggs with fecundity ranging from 23,900 to 149,300 for fish 83 cm and smaller in the Bering Sea (D'yakov 1982).

Eggs and early larval stages are benthypelagic (Musienko 1970). In the Atlantic Ocean, larvae (10-18 cm) have been found in benthypelagic waters which gradually rise to the pelagic zone in correspondence to absorption of the yolk sac which is reported to occur at 15-18 mm with the onset of feeding (Pertseva-Ostroumova 1961 and Smidt 1969). The period of larval development extends from April to as late as August or September (Jensen 1935) which results in an extensive larval drift and broad dispersal from the spawning waters of the continental slope. Metamorphosis occurs in August or September at about 7-8 cm in length at which time the demersal life begins. Juveniles are reported to be quite tolerant of cold temperatures to less than zero degrees Celsius (Hognestad 1969) and have been found on the northern part of the Bering Sea shelf in summer trawl surveys (Alton et al. 1988).

The age of 50% maturity is estimated to range from 5-10 yrs (D'yakov 1982, 60 cm used in stock assessment) and a natural mortality rate of 0.18 has been used in the most recent Bering Sea stock assessment (Ianelli et al. 2002).

Fishery

Greenland turbot are not a fishery target in the Gulf of Alaska. They are caught in bottom trawls and on longlines both as a directed fishery and in the pursuit of other bottom-dwelling species (primarily sablefish). These fisheries operate on the southern side of the Aleutian Islands. Bycatch primarily occurs in the sablefish directed fisheries and also to a smaller extent in the Pacific cod fishery. Recruitment begins at about 50 and 60 cm in the trawl and longline fisheries, respectively.

Relevant Trophic Information

Groundfish predators include Pacific cod, pollock and yellowfin sole, mostly on fish ranging from 2 to 5 cm standard length (probably age 0).

Approximate upper size limit of juvenile fish: 59 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for up to 9 months until metamorphosis occurs, usually with a widespread distribution inhabiting shallow waters. Juveniles live on continental shelf until about age 4 or 5 feeding primarily on euphausiids, polychaetes and small walleye pollock..

Adults: Inhabit continental slope waters with annual spring/fall migrations from deeper to shallower waters. Diet consists of walleye pollock and other miscellaneous fish species.

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SPECIES: Greenland turbot

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs		NA	winter	OCS MCS	SD, SP			
Larvae	8-9 months	U phyto/zoo plankton?	Spring summer	OCS ICS MCS	P			
Juveniles	1-5 yrs	euphausiids polychaets small pollock	all year	ICS MCS OCS USL	D, SD	M/S+M ¹		
Adults	5+ years	pollock small fish	spawning Nov-February non-spawning March-October	OCS USP LSP OCS	D, SD	M/S+M ¹		

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Habitat Description for Rock Sole

(Lepidopsetta bilineatus)

The shallow water flatfish management complex in the Gulf of Alaska is comprised of eight species: rock sole (*Lepidopsetta bilineata* and *Lepidopsetta polyxystra*), yellowfin sole (*Limanda aspera*), starry flounder (*Platichthys stellatus*), butter sole (*Isopsetta isolepis*), English sole (*Parophrys vetulus*), Alaska plaice (*Pleuronectes quadrituberculatus*) and sand sole (*Psettichthys melanostictus*). The rock sole resource in the Gulf of Alaska consists of two separate species; a northern and a southern form which have distinct characteristics and overlapping distributions. The two species of rock sole and yellowfin sole are the most abundant and commercially important species of this management complex in the Gulf of Alaska, and the description of their habitat and life history best represent the shallow water complex species.

Management Plan and Area GOA

Life History and General Distribution

Distributed from California waters north into the Gulf of Alaska and Bering Sea to as far north as the Gulf of Anadyr. The distribution continues along the Aleutian Islands westward to the Kamchatka Peninsula and then southward through the Okhotsk Sea to the Kurile Islands, Sea of Japan, and off Korea. Centers of abundance occur off the Kamchatka Peninsula (Shubnikov and Lisovenko 1964), British Columbia (Forrester and Thompson 1969), the central Gulf of Alaska, and in the southeastern Bering Sea (Alton and Sample 1975). Adults exhibit a benthic lifestyle and, in the eastern Bering Sea, occupy separate winter (spawning) and summertime feeding distributions on the continental shelf. Rock sole spawn during the winter-early spring period of December-March. Soviet investigations in the early 1960s established two spawning concentrations: an eastern concentration north of Unimak Island at the mouth of Bristol Bay and a western concentration eastward of the Pribilof Islands between 55°30' and 55°0' N and approximately 165°2' W (Shubnikov and Lisovenko, 1964). Rock sole spawning in the eastern and western Bering Sea was found to occur at depths of 125-250 m, close to the shelf/slope break. Spawning females deposit a mass of eggs which are demersal and adhesive (Alton and Sample 1975). Fertilization is believed to be external. Incubation time is temperature dependent and may range from 6.4 days at 11 degrees C to about 25 days at 2.9 degrees C (Forrester 1964). Newly hatched larvae are pelagic and have occurred sporadically in eastern Bering Sea plankton surveys (Waldron and Vinter, 1978). Kamchatka larvae are reportedly 20 mm in length when they assume their side-swimming, bottom-dwelling form (Alton and Sample 1975). Forrester and Thompson (1969) report that by age 1 they are found with adults on the continental shelf during summer.

In the springtime, after spawning, rock sole begin actively feeding and commence a migration to the shallow waters of the continental shelf. This migration has been observed on both the eastern (Alton and Sample, 1975) and western (Shvetsov 1978) areas of the Bering Sea. During this time they spread out and form much less dense concentrations than during the spawning period. Summertime trawl surveys indicate most of the population can be found at depths from 50-100 m (Armistead and Nichol 1993). The movement from winter/spring to summer grounds is in response to warmer temperatures in the shallow waters and the distribution of prey on the shelf seafloor (Shvetsov 1978). In September, with the onset of cooling in the northern latitudes, rock sole begin the return migration to the deeper wintering grounds. Fecundity varies with size and was reported to be 450,000 eggs for fish 42 cm long. Larvae are pelagic but their occurrence in plankton surveys in the eastern Bering Sea are rare (Musienko 1963). The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in

shallow areas until they reach age 1 (Forrester 1969). The estimated age of 50% maturity is 9 yrs for southern rock sole females (approx. 35 cm) and 7 years for northern rock sole females (Stark and Somerton 2002). Natural mortality rate is believed to range from 0.18 - 0.20 (Tournock et al. 2002).

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 4 and they are fully selected at age 11. Historically, the fishery has occurred throughout the mid and inner Bering Sea shelf during ice-free conditions and on spawning concentrations north of the Alaska Peninsula during winter for their high-value roe. They are caught as bycatch in Pacific cod, bottom Pollock and other flatfish fisheries and are caught with these species and Pacific halibut in rock sole directed fisheries.

Relevant Trophic Information

Groundfish predators to rock sole include Pacific cod, walleye pollock, skates, Pacific halibut and yellowfin sole, mostly on fish ranging from 5 to 15 cm standard length.

Approximate upper size limit of juvenile fish: 34 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2-3 months until metamorphosis occurs, juveniles inhabit shallow areas at least until age 1.

Adults: Summertime feeding on primarily sandy substrates of the eastern Bering Sea shelf. Widespread distribution mainly on the middle and inner portion of the shelf, feeding on bivalves, polychaetes, amphipods and miscellaneous crustaceans. Wintertime migration to deeper waters of the shelf margin for spawning and to avoid extreme cold water temperatures, feeding diminishes.

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SPECIES: Rock sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	winter	OCS	D			
Larvae	2-3 months?	U phyto/zoo plankton?	winter/spring	OCS MCS ICS	P			
Early Juveniles	to 3.5 years	polychaetes bivalves amphipods misc. crust.	all year	BAY ICS OCS MCS	D	S ¹ ,G		
Late Juveniles	up to 9 years	polychaetes bivalves amphipods misc. crust.	all year	BAY ICS OCS MCS	D	S ¹ ,G		
Adults	9+ years	polychaetes bivalves amphipods misc. crust.	feeding May- September	MCS ICS	D	S ¹ , G	ice edge	

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Habitat Description for Yellowfin sole

(Limanda aspera)

Management Plan and Area Shallow water flatfish complex in the GOA

Life History and General Distribution

Distributed in North American waters from off British Columbia, Canada, (approx. lat. 49° N) to the Chukchi Sea (about lat. 70° N) and south along the Asian coast to about lat. 35° N off the South Korean coast in the Sea of Japan. Adults exhibit a benthic lifestyle and occupy separate winter spawning and summertime feeding distributions on the eastern Bering Sea shelf. From over-winter grounds near the shelf margins, adults begin a migration onto the inner shelf in April or early May each year for spawning and feeding. A protracted and variable spawning period may range from as early as late May through August occurring primarily in shallow water. Fecundity varies with size and was reported to range from 1.3 to 3.3 million eggs for fish 25-45 cm long. Eggs have been found to the limits of inshore ichthyoplankton sampling over a widespread area to at least as far north as Nunivak Island. Larvae have been measured at 2.2-5.5 mm in July and 2.5-12.3 mm in late August - early September. The age or size at metamorphosis is unknown. Juveniles are separate from the adult population, remaining in shallow areas until they reach approximately 15 cm. The estimated age of 50% maturity is 10.5 yrs (approx. 29 cm) for females based on samples collected in 1992 and 1993. Natural mortality rate is believed to range from 0.12-0.16.

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 6 and they are fully selected at age 13. Historically, the fishery has occurred throughout the mid and inner Bering Sea shelf during ice-free conditions although much effort has been directed at the spawning concentrations in nearshore northern Bristol Bay. They are caught as bycatch in Pacific cod, bottom pollock and other flatfish fisheries and are caught with these species and Pacific halibut in yellowfin sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod, skates and Pacific halibut, mostly on fish ranging from 7 to 25 cm standard length.

Approximate upper size limit of juvenile fish: 27 cm

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2-3 months until metamorphosis occurs, usually inhabiting shallow areas.

Adults: Summertime spawning and feeding on sandy substrates of the eastern Bering Sea shelf. Widespread distribution mainly on the middle and inner portion of the shelf, feeding mainly on bivalves, polychaetes, amphipods and echiurids.. Wintertime

migration to deeper waters of the shelf margin to avoid extreme cold water temperatures, feeding diminishes.

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SPECIES: Yellowfin sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	summer	BAY, BCH	P			
Larvae	2-3 months?	U phyto/zoo plankton?	summer autumn?	BAY BCH ICS	P			
Early Juveniles	to 5.5 yrs	polychaetes bivalves amphipods echiurids	all year	BAY ICS OCS MCS	D	S ¹		
Late Juveniles	5.5 to 10 yrs	polychaetes bivalves amphipods echiurids	all year	BAY ICS, OCS, MCS IP	D	S ¹		
Adults	10+ years	polychaetes bivalves amphipods echiurids	spawning/ feeding May-August non-spawning Nov.-April	BAY BEACH ICS, MCS, OCS IP	D	S ¹	ice edge	

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Habitat Description for Rex Sole

(Glyptocephalus zachirus)

Management Plan and Area GOA

Life History and General Distribution

Distributed from Baja California to the Bering Sea and western Aleutian Islands (Hart 1973, Miller and Lea 1972), and are widely distributed throughout the Gulf of Alaska. Adults exhibit a benthic lifestyle and are generally found in water deeper than 300 meters. From over-winter grounds near the shelf margins, adults begin a migration onto the mid and outer continental shelf in April or May each year. The spawning period off Oregon is reported to range from January through June with a peak in March and April (Hosie and Horton 1977). Spawning in the Gulf of Alaska was observed from February through July, with a peak period in April and May (Hirschberger and Smith 1983). Eggs have been collected in neuston and bongo nets mainly in the summer, east of Kodiak Island (Kendall and Dunn 1985), but the duration of the incubation period is unknown. Larvae were captured in bongo nets only in summer over midshelf and slope areas (Kendall and Dunn 1985). Fecundity estimates from samples collected off the Oregon coast ranged from 3,900 to 238,100 ova for fish 24-59 cm (Hosie and Horton 1977). The age or size at metamorphosis is unknown. Maturity studies from Oregon indicate that males were 50% mature at 16 cm and females at 24 cm. Juveniles less than 15 cm are rarely found with the adult population. The natural mortality rate used in recent stock assessments is 0.2 (Turnock et al. 2002).

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3 or 4. They are caught as bycatch in the Pacific ocean perch, Pacific cod, bottom pollock and other flatfish fisheries and are caught with these species and Pacific halibut in rex sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod and most likely arrowtooth flounder.

Approximate upper size limit of juvenile fish: Males 15 cm and females 23 cm.

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for an unknown time period until metamorphosis occurs, juvenile distribution is unknown.

Adults: Spring spawning and summer feeding on a combination of sand, mud and gravel substrates of the continental shelf. Widespread distribution mainly on the middle and outer portion of the shelf, feeding mainly on polychaetes, amphipods, euphausiids and snow crabs.

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SPECIES: Rex sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	Feb - May	ICS? MCS OCS	P			
Larvae	U	U phyto/zoo plankton?	spring summer	ICS? MCS OCS	P			
Juveniles	2 years	polychaetes amphipods euphausiids Tanner crab	all year	MCS ICS OCS	D	G, S, M		
Adults	2+ years	polychaetes amphipods euphausiids Tanner crab	spawning Feb-May non-spawning May-January	MCS, OCS USP	D	G, S, M		

Habitat Description for Flathead Sole

(Hippoglossoides elassodon)

Management Plan and Area GOA

Life History and General Distribution

Distributed from northern California, off Point Reyes, northward along the west coast of North America and throughout the Gulf of Alaska and the Bering Sea, the Kuril Islands and possibly the Okhotsk Sea (Hart 1973).

Adults exhibit a benthic lifestyle and occupy separate winter spawning and summertime feeding distributions on the eastern Bering Sea shelf and in the Gulf of Alaska. From over-winter grounds near the shelf margins, adults begin a migration onto the mid and outer continental shelf in April or May each year for feeding. The spawning period may range from as early as January but is known to occur in March and April, primarily in deeper waters near the margins of the continental shelf. Eggs are large (2.75-3.75 mm) and females have egg counts ranging from about 72,000 (20 cm fish) to almost 600,000 (38 cm fish). Eggs hatch in 9 to 20 days depending on incubation temperatures within the range of 2.4 to 9.8°C and have been found in ichthyoplankton sampling on the southern portion of the Bering Sea shelf in April and May (Waldron 1981). Larvae absorb the yolk sac in 6 to 17 days but the extent of their distribution is unknown. Nearshore sampling indicates that newly settled larvae are in the 40-50 mm size range (Norcross et al. 1996). Flathead sole females in the Gulf of Alaska become 50% mature at eight years or about 32 cm (Turnock et al. 2002). Juveniles less than age 2 have not been found with the adult population, remaining in shallow areas. The natural mortality rate used in recent stock assessments is 0.2.

Fishery

Caught in bottom trawls both as a directed fishery and in the pursuit of other bottom-dwelling species. Recruitment begins at about age 3. Historically, the fishery has occurred throughout the mid and outer Bering Sea shelf during ice-free conditions (mostly summer and fall). They are caught as bycatch in Pacific cod, bottom Pollock and other flatfish fisheries and are caught with these species and Pacific halibut in flathead sole directed fisheries.

Relevant Trophic Information

Groundfish predators include Pacific cod, Pacific halibut, arrowtooth flounder and also cannibalism by large flathead sole, mostly on fish less than 20 cm standard length.

Approximate upper size limit of juvenile fish: 31 cm.

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for 3 to 5 months until metamorphosis occurs, usually inhabiting shallow areas.

Adults: Winter spawning and summer feeding on sand and mud substrates of the continental shelf. Widespread distribution mainly on the middle and outer portion of the shelf, feeding mainly on ophiuroids, tanner crab, osmerids, bivalves and polychaetes.

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SPECIES: Flathead sole

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	winter	ICS MCS OCS	P			
Larvae	U	U phyto/zoo plankton?	spring summer	ICS MCS OCS	P			
Juveniles	U	polychaetes bivalves ophiuroids	all year	MCS ICS OCS	D	S+M ¹		
Adults	U	polychaetes bivalves ophiuroids pollock and Tanner crab	spawning Jan-April non-spawning May-	MCS OCS ICS	D	S+M ¹	ice edge	

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Habitat Description for Arrowtooth Flounder

(Atheresthes stomias)

Management Plan and Area GOA

Life History and General Distribution

Distributed in North American waters from central California to the eastern Bering Sea on the continental shelf and upper slope.

Adults exhibit a benthic lifestyle and occupy separate winter and summer distributions on the eastern Bering Sea shelf. From over-winter grounds near the shelf margins and upper slope areas, adults begin a migration onto the middle and inner shelf in April or early May each year with the onset of warmer water temperatures. A protracted and variable spawning period may range from as early as September through March (Rickey 1994, Hosie 1976). Little is known of the fecundity of arrowtooth flounder. Larvae have been found from ichthyoplankton sampling over a widespread area of the eastern Bering Sea shelf in April and May and also on the continental shelf east of Kodiak Island during winter and spring (Waldron and Vinter 1978, Kendall and Dunn 1985). Nearshore sampling in the Kodiak Island area indicates that newly settled larvae are in the 40-60 mm size range (Norcross et al. 1996). Juveniles are separate from the adult population, remaining in shallow areas until they reach the 10-15 cm range (Martin and Clausen 1995). The estimated length at 50% maturity is 28 cm for males (4 years) and 37 cm for females (5 years) from samples collected off the Washington coast (Rickey 1994) and 47 cm for Gulf of Alaska females (Zimmerman 1997). The natural mortality rate used in stock assessments differs by sex with females estimated at 0.2 and male natural mortality ranging from 0.28 to 0.35 (Turnock et. al 2002, Wilderbuer and Sample 2002).

Fishery

Caught in bottom trawls usually in pursuit of other higher value bottom-dwelling species. Historically have been undesirable to harvest due to a flesh softening condition caused by protease enzyme activity. Recruitment begins at about age 3 and females are fully selected at age 10. They are caught as bycatch in Pacific cod, bottom Pollock, sablefish and other flatfish fisheries.

Relevant Trophic Information

Very important as a large, aggressive and abundant predator of other groundfish species. Groundfish predators include Pacific cod and pollock, mostly on small fish.

Approximate upper size limit of juvenile fish: Males 27 cm and females 46 cm.

Habitat and Biological Associations

Larvae/Juveniles: Planktonic larvae for at least 2-3 months until metamorphosis occurs, juveniles usually inhabit shallow areas until about 10 cm in length.

Adults: Widespread distribution mainly on the middle and outer portions of the continental shelf, feeding mainly on walleye pollock and other miscellaneous fish species when arrowtooth flounder attain lengths greater than 30 cm. Wintertime migration to

deeper waters of the shelf margin and upper continental slope to avoid extreme cold water temperatures and for spawning.

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SPECIES: Arrowtooth flounder

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs		NA	winter, spring?	ICS OCS	P			
Larvae	2-3 months?	U phyto/zoo plankton?	spring summer?	BAY ICS OCS	P			
Juveniles	males - 4 yrs females - 5 yrs	euphausiids crustaceans amphipods pollock	all year	ICS OCS USP	D	GMS ¹		
Adults	males - 4+ yrs females- 5+ yrs	pollock misc. fish Gadidae sp. Euphausiids	spawning Nov-March non-spawning	ICS OCS USP BAY	D	GMS ¹	ice edge (EBS)	

¹Pers. Comm., Dr. Robert McConnaughey (206) 526-4150

Habitat Description for Sablefish

(Anoplopoma fimbria)

Management Plan and Area GOA

Life History and General Distribution

Distributed from Mexico through the Gulf of Alaska to the Aleutian Chain, Bering Sea; along the Asian coast from Sagami Bay, and along the Pacific sides of Honshu and Hokkaido Islands and the Kamchatkan Peninsula. Adult sablefish occur along the continental slope, shelf gullies, and in deep fjords such as Prince William Sound and Southeastern Alaska, at depths generally greater than 200 m. Adults are assumed to be demersal. Spawning or very ripe sablefish are observed in late winter or early spring along the continental slope. Eggs are apparently released near the bottom where they incubate. After hatching and yolk adsorption the larvae rise to the surface where they have been collected with neuston nets. Larvae are oceanic through the spring and by late summer, small pelagic juveniles (10-15 cm) have been observed along the outer coasts of Southeast Alaska, where they apparently move into shallow waters to spend their first winter. During most years, there are only a few places where juveniles have been found during their first winter and second summer. It is not clear if the juvenile distribution is highly specific or appears so because sampling is highly inefficient and sparse. During the occasional times of large year-classes the juveniles are easily found in many inshore areas during their second summer. They are typically 30-40 cm in length during their second summer, after which they apparently leave the nearshore bays. One or two years later they begin appearing on the continental shelf and move to their adult distribution as they mature.

Fishery

The major fishery for sablefish in Alaska uses longlines, however sablefish are valuable in the trawl fishery as well. Sablefish enter the longline fishery at 4-5 years of age, perhaps slightly younger in the trawl fishery. The longline fishery takes place between March 1 and November 15. The take of the trawl share of sablefish occurs primarily in association with openings for other species, such as the July rockfish openings, where they are taken as allowed bycatch. Deeper dwelling rockfish, such as Shortraker, Rougheye, and Thornyhead rockfish are the primary bycatch in the longline sablefish fishery. Halibut and rattails (*Albatrossia pectoralis* and *Corphaenoides acrolepis*) also are taken. By regulation, there is no directed trawl fishery for sablefish, however, directed fishing standards have allowed some trawl hauls to target sablefish, where the bycatch is similar to the longline fishery, in addition perhaps to some deep dwelling flatfish.

Relevant Trophic Information

Larval sablefish feed on a variety of small zooplankton ranging from copepod naupli to small amphipods. The epipelagic juveniles feed primarily on macrozooplankton and micronekton (i.e., euphausiids).

The older demersal juveniles and adults appear to be opportunistic feeders, with food ranging from variety of benthic invertebrates, benthic fishes, as well as squid, mesopelagic fishes, jellyfish and fishery discards. Gadid fish (mainly pollock) comprise a large part of the sablefish diet. Nearshore residence during their second year provide the opportunity to feed on salmon fry and smolts during the summer months.

Young of the year sablefish are commonly found in the stomachs of salmon taken in the SE troll fishery during the late summer.

Approximate upper size limit of juvenile fish (in cm):

Size of 50% maturity: Bering Sea: males 65 cm, females 67 cm; Aleutian Islands: males 61 cm, females 65 cm; Gulf of Alaska: males 57 cm, females 65 cm. At the end of the second summer (~1.5 years old) they are 35-40 cm in length.

Additional Information Sources

Eggs and Larvae: NMFS, Alaska Fisheries Science Center, FOCI Program, Art Kendall 206-526-4108, NMFS Auke Bay Lab, Bruce Wing 907-789-6043.

Juveniles: ADFG groundfish surveys: Jim Blackburn, ADFG, Kodiak AK 907-486-186, Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961

Kendall, A.W. and A.C. Materese. Biology of eggs, larvae, and epipelagic juveniles of sablefish, *Anoplopoma fimbria*, in relation to their potential use in management. Mar. Fish. Rev. 49(1)1-13.

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Habitat and Biological Associations (if known) Narrative

Egg/Spawning

Larvae

Juveniles

Adults - other than depth, none is noted.

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SPECIES: Gulf of Alaska Sablefish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	14-20 days	NA	late winter-early spring: Dec-Apr	USP, LSP, BSN	P,200-3000 m	NA	U	
Larvae	up to 3 months	copepod nauplii, small copepodites, etc	spring-summer: Apr-July	MCS, OCS, USP, LSP, BSN	N, neustonic near surface	NA	U	
Early Juveniles	up to 3 years	small prey fish, sandlance, salmon, herring, etc		OCS, MCS, ICS, during first summer, then obs in BAY, IP, till end of 2nd summer; not obs'd till found on shelf	P when offshore during first summer, then D, SD/SP when inshore	NA when pelagic. The bays where observed were soft bottomed, but not enough obs. to assume typical.	U	
Late Juveniles	3-5 yrs	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	all year	continental slope, and deep shelf gullies and fjords.	presumably D	varies	U	
Adults	5 to 35+ yrs	opportunistic: other fish, shellfish, worms, jellyfish, fishery discards	apparently year around, spawning movements (if any) are undescribed	continental slope, and deep shelf gullies and fjords.	presumably D	varies	U	

Habitat Description for Pacific Ocean Perch

(Sebastes alutus)

Management Plan and Area GOA

Life History and General Distribution

Pacific ocean perch has a wide distribution in the North Pacific from southern California around the Pacific rim to northern Honshu Is., Japan, including the Bering Sea. The species appears to be most abundant in northern British Columbia, the Gulf of Alaska, and the Aleutian Islands. Adults are found primarily offshore on the outer continental shelf and the upper continental slope in depths 150-420 m. Seasonal differences in depth distribution have been noted by many investigators. In the summer, adults inhabit shallower depths, especially those between 150 and 300 m. In the fall, the fish apparently migrate farther offshore to depths of ~300-420 m. They reside in these deeper depths until about May, when they return to their shallower summer distribution. This seasonal pattern is probably related to summer feeding and winter spawning. Although small numbers of Pacific ocean perch are dispersed throughout their preferred depth range on the continental shelf and slope, most of the population occurs in patchy, localized aggregations. Pacific ocean perch are generally considered to be semi-demersal but there can at times be a significant pelagic component to their distribution. Apparently, Pacific ocean perch often move off-bottom at night to feed, and commercial fishing data in the GOA since 1995 show that pelagic trawls fished off-bottom have accounted for as much as 20% of the annual harvest of this species.

There is much uncertainty about the life history of Pacific ocean perch, although generally more is known than for other rockfish species. The species appears to be viviparous (the eggs develop internally and receive at least some nourishment from the mother), with internal fertilization and the release of live young. Insemination occurs in the fall, and sperm are retained within the female until fertilization takes place ~2 months later. The eggs hatch internally, and parturition (release of larvae) occurs in April-May. Information on early life history is very sparse, especially for the first year of life. Pacific ocean perch larvae are thought to be pelagic and to drift with the current, but larval studies of rockfish have been hindered by difficulties in species identification. At present, positive identification of Pacific ocean perch larvae is only possible using genetic techniques, which are expensive and labor intensive. Recently, post-larval and early young-of-the-year Pacific ocean perch have been positively identified in samples collected in July and August in offshore, surface waters of the Gulf of Alaska, which suggests this may be the preferred habitat of this life stage. Transformation to a demersal existence may take place within the first year. Small juveniles probably reside inshore in very rocky, high relief areas, and by age 3 begin to migrate to deeper offshore waters of the continental shelf. As they grow, they continue to migrate deeper, eventually reaching the continental slope, where they attain adulthood.

Pacific ocean perch is a very slow growing species, with a low rate of natural mortality (estimated at 0.05), a relatively old age at 50% maturity (10.5 years for females in the Gulf of Alaska), and a very old maximum age of 98 years in Alaska (84 years maximum age in the Gulf of Alaska). Age at 50% recruitment to the commercial fishery has been estimated to be between 9 and 10 years in the Gulf of Alaska. Despite their viviparous nature, the fish is relatively fecund with number of eggs/female in Alaska ranging from 10,000-300,000, depending upon size of the fish.

Fishery

Pacific ocean perch are caught almost exclusively with trawls. Before 1996, nearly all the catch was taken by factory trawlers using bottom trawls, but since then a sizeable portion (up to 20% some years) has also been taken by pelagic trawls. Also in 1996, a shore-based fishery developed that consisted of smaller vessels

operating out of the port of Kodiak. These shore-based trawlers now take about 50% of the catch in the central GOA. The fishery in the Gulf in recent years has occurred in the summer months, especially July, due to management regulations. Reflecting the summer distribution of this species, the fishery is concentrated in a relatively narrow depth band at ~180-250 m along the outer continental shelf and shelf break, inside major gullies and trenches running perpendicular to the shelf break, and along the upper continental slope. Major fishing grounds include Ommaney Trough (which is no longer fished because of a NPFMC amendment that prohibits trawling in the eastern GOA), Yakutat Canyon, Amatuli Trough, off Portlock and Albatross Banks, Shelikof Trough, off Shumagin Bank, and south of Unimak and Unalaska Is.

Major bycatch species in the Gulf of Alaska Pacific ocean perch trawl fishery in 1994- 96 (the most recent years for which an analysis was done) included (in descending order by percent bycatch rate): other species of rockfish, arrowtooth flounder, and sablefish. Among the “other species of rockfish,” northern rockfish and shortraker/rougheye were most common, followed by pelagic shelf rockfish.

Relevant Trophic Information

All food studies of Pacific ocean perch have shown them to be overwhelmingly planktivorous. Small juveniles eat mostly calanoid copepods, whereas larger juveniles and adults consume euphausiids as their major prey items. Adults, to a much lesser extent, may also eat small shrimp and squids. It has been suggested that Pacific ocean perch and walleye pollock compete for the same euphausiid prey. Consequently, the large removals of Pacific ocean perch by foreign fishermen in the Gulf of Alaska in the 1960s may have allowed walleye pollock stocks to greatly expand in abundance.

Documented predators of adult Pacific ocean perch include, Pacific halibut, sablefish, and sperm whales, and it is likely that Pacific cod and arrowtooth flounder also prey on Pacific ocean perch. Pelagic juveniles are consumed by salmon, and benthic juveniles are eaten by lingcod and other large demersal fish.

Describe any potential gear impacts on the habitats of this or other species

Because collection of small juvenile Pacific ocean perch is virtually unknown in any existing type of commercial fishing gear, it is assumed that fishing does not occur in their habitat. Trawling on the offshore fishing grounds of adults may affect the composition of benthic organisms, but the impact of this on Pacific ocean perch or other fish is unknown.

Approximate upper size limit of juvenile fish (in cm):

For Gulf of Alaska: 38 cm for females; unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*.

Additional Information

Larvae: NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory, Bruce Wing, (907) 789-6043; NMFS, Alaska Fisheries Science Center, FOCI program, Ann Matarese (206) 526-4111; Art Kendall, AJALA Enterprises, La Conner, WA, (360) 466-0470.

Juveniles: Carlson, H.R. And R.E. Haight. 1976 . Juvenile life of Pacific ocean perch, *Sebastes alutus*, in coastal fiords of southeastern Alaska: Their environment, growth, food habits, and schooling behavior. Trans. Am. Fish. Soc. 105:191-201.

Adults: Lunsford, C. R. 1999. Distribution patterns and reproductive aspects of Pacific ocean perch (*Sebastes alutus*) in the Gulf of Alaska. M.S. Thesis. Univ. of Alaska Fairbanks, Juneau AK. 154 p.

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Little information is known. Insemination is thought to occur after adults move to deeper offshore waters in the fall. Parturition is reported to occur from 20-30 m off bottom at depths of 360-400 m.

Larvae: Little information is known. Earlier information suggested that after parturition, larvae rise quickly to near surface, where they become part of the plankton. More recent data from British Columbia indicates that larvae may remain at depths >175 m for some period of time (perhaps two months), after which they slowly migrate upward in the water column.

Post-larvae and early young-of-the year: A recent, preliminary study has identified Pacific ocean perch in these life stages from samples collected in epipelagic waters far offshore in the Gulf of Alaska. Some of the samples were as much as 100 n. m. from land, beyond the continental slope and over very deep water.

Juveniles: Again, information is very sparse, especially for younger juveniles. It is unknown how long young-of-the-year remain in a pelagic stage before eventually becoming demersal. At age 1-3 the fish probably live in very rocky inshore areas. Afterward, they move to progressively deeper waters of the continental shelf. Older juveniles are often found together with adults at shallower locations of the continental slope in the summer months.

Adults: Commercial fishery and research data have consistently indicated that adult Pacific ocean perch are found in aggregations over reasonably smooth, trawlable bottom of the outer continental shelf and upper continental slope. Generally, they are found in shallower depths (150-300 m) in the summer, and deeper (300-420 m) in the fall, winter, and early spring. Observations in southeastern Alaska from a manned submersible found adult Pacific ocean perch associated with pebble substrate on flat or low-relief bottom. Pacific ocean perch have been observed in association with sea whips in both the GOA and the Bering Sea. The fish can at times also be found off bottom in the pelagic environment, especially at night when they may move up in the water column to feed. There presently is no evidence to support previous conjectures that adult Pacific ocean perch might sometimes inhabit rough, untrawlable bottom.

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SPECIES: Gulf of Alaska Pacific Ocean Perch

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	Internal incubation; ~90 d	NA	Winter-spring	NA	NA	NA	NA	NA
Larvae	U; 2 months (?)	U; assumed to be micro-zooplankton	Spring-summer	ICS, MCS, OCS, USP, LSP, BSN	P	NA	U	U
Post-larvae/early juvenile	U; 2 months to ?	U	Summer to ?	LSP, BSN	Epipelagic	NA	U	U
Juveniles	<1 year (?) to 10 years	Calanoid copepods (young juv.); Euphausiids (older juv.)	All year	ICS, MCS, OCS, USP	D	R (<age 3); CB,G,?M, ?SM,?MS (>age 3)	U	U
Adults	10-84 years of age (98 years in Aleutian Islands)	Euphausiids	Insemination (fall); Fertilization, incubation (winter); Larval release (spring); Feeding in shallower depths (summer)	OCS, USP	D, SD, P	CB, G,?M, ?SM,?MS	U	U

Habitat Description for Shortraker Rockfish (*Sebastes borealis*) and Rougheye Rockfish (*Sebastes aleutianus*)

Management Plan and Area GOA

Life History and General Distribution

Shortraker and rougheye rockfishes are found around the arc of the north Pacific from southern California to northern Japan, including the Bering Sea. Both species are demersal and inhabit depths ranging from 25 to 875 m; however, commercial concentrations are usually found along a narrow band of the continental slope at depths of 300-500 m, where both shortraker and rougheye rockfish often co-occur in the same haul. Similar to other *Sebastes*, the fish appear to be viviparous (the eggs develop internally and receive at least some nourishment from the mother), with internal fertilization and the release of live young. Though relatively little is known about their biology and life history, both species appear to be K-selected with late maturation, slow growth, extreme longevity, and low natural mortality. Rougheye rockfish attain maturity relatively late in life, at about 20+ years of age. Age of maturity for shortraker rockfish is unknown, but is presumably similar to that of rougheye rockfish. Both species are among the largest *Sebastes* species in Alaskan waters, attaining sizes of up to 104 cm for shortraker and 96 cm for rougheye rockfish. Shortraker and rougheye rockfish are estimated to attain ages in excess of 100 years, and one ageing laboratory has reported ages up to 157 years for shortraker and 205 years for rougheye. Natural mortality for both species is low, estimated to be on the order of 0.01 to 0.04.

Fishery

Shortraker and rougheye rockfish are presently managed as bycatch-only species in Alaska. Trawl and longline gear are the primary methods of harvest. Even though both species are found as far south as southern California, commercial quantities are primarily harvested from northern Washington throughout Alaskan waters. Depths of commercial harvests usually occur from about 300 to 500 m. Both species are associated with a variety of habitats from soft to rocky habitats along the continental slope, although boulders and sloping terrain appear to be a desirable habitat feature for both species. Trawling in such habitats often requires specialized fishing skills to avoid gear damage and to keep the trawl in the proper fishing configuration. Age at recruitment is uncertain, but is probably on the order of 20+ years for both species. Shortraker and rougheye rockfish are often caught as bycatch in trawl and longline fisheries for sablefish and halibut.

Relevant Trophic Information

Rougheye rockfishes prey primarily on shrimps, and various fish species are also consumed. The diet of shortraker rockfish is not well-known; however, based on a small number of samples, the diet appears to be mostly squid, shrimp, and deepwater fish such as myctophids. It is uncertain what are the main predators on both species.

Approximate upper size limit of juvenile fish (in cm):

For shortraker rockfish, length at 50% sexual maturity is about 45 cm and about 44 cm for rougheye rockfish

Additional Information Sources

Larvae: Art Kendall, AJALA Enterprises, La Conner, WA, (360) 466-0470.

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: The timing of reproductive events is apparently protracted. One study indicated that vitellogenesis was present for four to five months and lasted from about July until late October and November. Parturition apparently occurs mainly in early spring through summer.

Larvae: No information is available regarding the habitats and biological associations of shortraker and rougheye rockfish larvae.

Post-larvae and early young-of-the year: A recent, preliminary study has identified two specimens of shortraker rockfish and one of rougheye rockfish in these life stages from samples collected in epipelagic waters far offshore in the Gulf of Alaska. This limited information is the only documentation of habitat preferences for these life stages.

Juveniles: Little information is available regarding the habitats and biological associations of shortraker and rougheye rockfish juveniles. This is especially true for shortraker rockfish, as only a few specimens <40 cm fork length have ever been caught in the Gulf of Alaska. In contrast, juvenile rougheye rockfish 15-40 cm fork length are frequently caught in GOA trawl surveys. They are generally found at shallower, more inshore areas than adults. These areas range from inshore fiords to offshore waters of the continental shelf, but habitat preferences for the fish within these environments is unknown.

Adults: Adults are demersal and are concentrated at depths of 300-500 m along the continental slope. Observations from a manned submersible indicate that these fish occur over a wide range of habitats. Soft substrates of sand or mud usually had the highest densities, whereas hard substrates of bedrock, cobble or pebble usually had the lowest adult densities. Habitats with steep slopes and frequent boulders were used at a higher rate than habitats with gradual slopes and few boulders. Submersible studies have also shown adults of the two species are sometimes associated with *Primnoa* spp. coral.

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SPECIES: Shortraker and Roughey Rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	NA	NA	NA	NA	NA	NA	
Larvae	U	U	Parturition: Early spring through summer	U	U	U	U	
Post-larvae/ early juvenile	< 6 months	U	Summer	U, LSP, BSN	Epipelagic	NA	U	
Juveniles	Up to 20 yrs of age	U Shrimp & amphipods?	U	U (short- raker) ICS, MCS, OCS?	U (shortraker) D (roughey)	U	U	
Adults	20 to >100 yrs of age	Shrimp Squid Myctophids	Year-round?	OCS, USP	D	M, S, R, SM, CB, MS, G, steep slopes and boulders	U	Observed associated with <i>Primnoa</i> coral

Habitat Description for Northern Rockfish

(Sebastes polypinus)

Management Plan and Area GOA

Life History and General Distribution

Northern rockfish range from northern British Columbia through the Gulf of Alaska and Aleutian Islands to eastern Kamchatka, including the Bering Sea. The species is most abundant from about Portlock Bank in the central Gulf of Alaska to the western end of the Aleutian Islands. Within this range, adult fish appear to be concentrated at discrete, relatively shallow offshore banks of the outer continental shelf. Typically, these banks are separated from land by an intervening stretch of deeper water. The preferred depth range is ~75-150 m in the Gulf of Alaska. Information available at present suggests the fish are mostly demersal, as very few have been caught in pelagic trawls. In common with many other rockfish species, northern rockfish tend to have a localized, patchy distribution, even within their preferred habitat, and most of the population occurs in aggregations. Most of what is known about northern rockfish is based on data collected during the summer months from the commercial fishery or in research surveys. Consequently, there is little information on seasonal movements or changes in distribution for this species.

Life history information on northern rockfish is extremely sparse. The fish are assumed to be viviparous, as other *Sebastes* appear to be, with internal fertilization and incubation of eggs. Observations during research surveys in the Gulf of Alaska suggest that parturition (larval release) occurs in the spring, and is mostly completed by summer. Pre-extrusion larvae have been described, but field-collected larvae cannot be identified to species at present. Length of the larval stage is unknown, but the fish apparently metamorphose to a pelagic juvenile stage, which also has been described. There is no information on when the juveniles become benthic or what habitat they occupy. Older juveniles are found on the continental shelf, generally at locations inshore of the adult habitat.

Northern rockfish is a slow growing species, with a low rate of natural mortality (estimated at 0.06), a relatively old age at 50% maturity (12.8 years for females in the Gulf of Alaska), and an old maximum age of 72 years in Alaska (maximum reported age in the GOA is 44 years). No information on fecundity is available.

Fishery

Northern rockfish are caught almost exclusively with bottom trawls. Age at 50% recruitment is unknown. The fishery in the Gulf of Alaska in recent years has mostly occurred in the summer months, especially July, due to management regulations. Catches are concentrated on live relatively shallow, offshore banks of the outer continental shelf: which include Portlock Bank, Albatross Bank, the "Snakehead" south of Kodiak Island, Shumagin Bank, and Davidson Bank. Of these, the Snakehead has been the most productive. Outside of these banks, catches are generally sparse. The majority of the catch in the Gulf of Alaska comes from depths of 75-125 m.

The major bycatch species in the Gulf of Alaska northern rockfish trawl fishery in 1994-96 included (in descending order by percent bycatch rate): light dusky rockfish, "other slope rockfish", and Pacific ocean perch. Of these, light dusky rockfish was by far the most common bycatch, having a bycatch rate as high as 34%, depending on the year.

Relevant Trophic Information

Although no comprehensive food study of northern rockfish has been done, smaller studies have ~~at~~ shown euphausiids to be the predominant food item of adults in both the Gulf of Alaska and Aleutian Islands. Copepods, hermit crabs, and shrimp have also been noted as prey items in much smaller quantities.

Predators of northern rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth flounder.

Approximate upper size limit of juvenile fish (in cm):

For Gulf of Alaska: 38 cm for females; unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*.

Additional Information Sources

Eggs and Larvae: None at present

Older juveniles and adults: NMFS, Alaska Fisheries Science Center, Auke Bay Laboratory, David Clausen, (907) 789-6049.

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: No information known, except that parturition probably occurs in the spring.

Larvae: No information known.

Juveniles: No information known for small juveniles (<20 cm), except that juveniles apparently undergo a pelagic phase immediately after metamorphosis from the larval stage. Larger juveniles have been taken in bottom trawls at various localities of the continental shelf, usually inshore of the adult fishing grounds. Substrate preference of these larger juveniles is unknown.

Adults: Commercial fishery and research survey data have consistently indicated that adult northern rockfish in the Gulf of Alaska are primarily found on offshore banks of the outer continental shelf at depths of 75-150 m. Preferred substrate in this habitat has not been documented, but observations from trawl surveys suggest that large catches of northern rockfish are often associated with hard or rough bottoms. For example, some of the largest catches in the trawl surveys have occurred in hauls in which the net hung-up on the bottom or was torn by a rough substrate. Generally, the fish appear to be demersal, and most of the population occurs in large aggregations. There is no information on seasonal migrations. Northern rockfish often co-occur with light dusky rockfish.

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SPECIES: Northern rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	NA	U	NA	NA	NA	NA	NA
Larvae	U	U	Spring-summer	U	P (assumed)	NA	U	U
Early Juveniles	From end of larval stage to ?	U	All year	U	?P	U	U	U
Late Juveniles	to 13 yrs	U	All year	MCS, OCS	D	U	U	U
Adults	13- 44 years of age (maximum of 72 yrs in Aleutian Is.)	Euphausiids	U, except that larval release is probably in the spring in the Gulf of Alaska	OCS,	D	CB, R	U	Often co-occur with light dusky rockfish

Habitat Description for Light Dusky Rockfish

(Sebastes ciliatus)

Note: Previously, the taxonomy of dusky rockfish was unclear. Two varieties occur which are now believed to be distinct species: an inshore, shallow water, dark-colored variety; and a lighter-colored variety found in deeper water offshore. A taxonomic study is soon to be completed that will describe the light variety as a new species. To avoid confusion, and because the light variety appears to be more abundant and is the object of a directed trawl fishery, this discussion of essential habitat will deal only with “light” dusky rockfish.

Management Plan and Area GOA

Life History and General Distribution

Light dusky rockfish range from Dixon Entrance at the U.S./Canada boundary, around the arc of the Gulf of Alaska, and westward throughout the Aleutian Islands. They are also found in the eastern Bering Sea north to about Zhemchug Canyon west of the Pribilof Is. In the northwest Pacific, dusky rockfish are reported to range southwestward to Japan, but it is unknown which variety this refers to. Their distribution south of Dixon Entrance in Canadian waters is likewise uncertain; dusky rockfish have been reported as far south as Johnstone Strait, Vancouver Is., but it is likely these were of the dark variety. The center of abundance for light dusky rockfish appears to be the Gulf of Alaska. Adult light dusky rockfish have a very patchy distribution, and are usually found in large aggregations at specific localities of the outer continental shelf. These localities are often relatively shallow offshore banks. Because the fish are taken with bottom trawls, they are presumed to be mostly demersal. Whether they also have a pelagic distribution is unknown, but there is no particular evidence of a pelagic tendency based on the information available at present. Most of what is known about light dusky rockfish is based on data collected during the summer months from the commercial fishery or in research surveys. Consequently, there is little information on seasonal movements or changes in distribution for this species.

Life history information on light dusky rockfish is extremely sparse. The fish are assumed to be viviparous, as are other *Sebastes*, with internal fertilization and incubation of eggs. Observations during research surveys in the Gulf of Alaska suggest that parturition (larval release) occurs in the spring, and is probably completed by summer. Another, older source, however, lists parturition as occurring “after May.” Pre-extrusion larvae have been described, but field-collected larvae cannot be identified to species at present. Length of the larval stage, and whether a pelagic juvenile stage occurs, are unknown. There is no information on habitat and abundance of young juveniles (<25 cm fork length), as catches of these have been virtually nil in research surveys. Even the occurrence of older juveniles has been very uncommon in surveys, except for one year. In this latter instance, older juveniles were found on the continental shelf, generally at locations inshore of the adult habitat.

Light dusky rockfish is a slow growing species, with a low rate of natural mortality estimated at 0.09. However, it appears to be faster growing than many other rockfish species. Maximum age is 51-59 years. Estimated age at 50% maturity for females is 11.3 years. No information on fecundity is available.

Fishery

Light dusky rockfish are caught almost exclusively with bottom trawls. A precise estimate of age at 50% recruitment is not available, but has been roughly estimated to be about 10 years based on length frequency information from the fishery. The fishery in the Gulf of Alaska in recent years has mostly occurred in the summer months, especially July, due to management regulations. Catches are concentrated at a number of

relatively shallow, offshore banks of the outer continental shelf, especially the “W” grounds west of Yakutat, and Portlock Bank. Other fishing grounds include Albatross Bank, the “Snakehead” south of Kodiak Island, and Shumagin Bank. Outside of these banks, catches are generally sparse. Most of the catch appears to be taken at depths of 100-200 m.

The major bycatch species in the Gulf of Alaska light dusky rockfish trawl fishery in 1994-96 included (in descending order by percent bycatch rate) northern rockfish and Pacific ocean perch.

Relevant Trophic Information

Although no comprehensive food study of light dusky rockfish has been done, one smaller study in the Gulf of Alaska showed euphausiids to be the predominate food item of adults. Larvaceans, cephalopods, pandalid shrimp, and hermit crabs were also consumed.

Predators of light dusky rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth flounder.

Approximate upper size limit of juvenile fish (in cm): For Gulf of Alaska: 47 cm for females (size at 50% maturity is 43 cm); unknown for males, but presumed to be slightly smaller than for females based on what is commonly the case in other species of *Sebastes*.

Additional Information Sources

Eggs, Larvae, and Juveniles: None at present.

Adults: Rebecca Reuter, c/o NMFS, Alaska Fisheries Science Center, REFM Division, (206) 526-4249.

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: No information known, except that parturition probably occurs in the spring, and may extend into summer.

Larvae: No information known.

Juveniles: No information known for small juveniles <25 cm fork length. Larger juveniles have been taken infrequently in bottom trawls at various localities of the continental shelf, usually inshore of the adult fishing grounds. A manned submersible study in the eastern Gulf observed juvenile (<40 cm) light dusky rockfish associated with *Primnoa* spp. coral.

Adults: Commercial fishery and research survey data indicate that adult light dusky rockfish are primarily found on offshore banks of the outer continental shelf at depths of 100-200 m. Type of substrate in this habitat has not been documented, but it may be rocky. During submersible dives on the outer shelf (40-50 m) in the eastern Gulf, adult light dusky rockfish were observed in association with rocky habitats and in areas with extensive sponge beds where the fish were observed resting in large vase sponges (pers. Comm. V. O’Connell). Light dusky rockfish are the most highly aggregated of the rockfish species caught in Gulf of Alaska trawl surveys. Outside of these aggregations, the fish are sparsely distributed. Because the fish are generally taken only with bottom trawls, they are presumed to be mostly demersal. Whether they also have a pelagic distribution is unknown, but there is no evidence of a pelagic tendency based on the information available at present. There is no information on seasonal migrations. Light dusky rockfish often co-occur with northern rockfish.

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SPECIES: Light dusky rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	NA	U	NA	NA	NA	NA	NA
Larvae	U	U	Spring-summer	U	P (assumed)	NA	U	U
Early Juveniles	U	U	All year	U	U	U	U	U
Late Juveniles	Up to 11 years	U	U	ICS, MCS, OCS	D	CB, R, G	U	Observed associated with <i>Primnoa</i> coral
Adults	11 up to 51-59 years.	Euphausiids	U, except that larval release may be in	OCS, USP	D,	CB, R, G	U	Observed associated with large vase-type sponges

Habitat Description for Yelloweye Rockfish (*Sebastes ruberrimus*) and Other Demersal Rockfishes

Management Plan and Area GOA

Yelloweye rockfish *Sebastes ruberrimus* (primary species, described below)
Quillback rockfish, *Sebastes maliger*
Rosethorn rockfish, *Sebastes helvomaculatus*
Tiger rockfish, *Sebastes nigrocinctus*
Canary rockfish, *Sebastes pinniger*
China rockfish, *Sebastes nebulosus*
Copper rockfish, *Sebastes caurinus*

Life History and General Distribution

Distributed from Ensenada, northern Baja California to Umnak I. and Unalaska I., Aleutians in depths from 60 to 1800 feet but commonly in 300 to 600 ft in rocky, rugged habitat (Allen and Smith, 1988, Eschmeyer et al 1983). Little is known about the young of the year and settlement. Young juveniles between 2.5 cm and 10 cm have been observed in areas of high and steep relief, in depths deeper than 15 m. Subadult and adult fish are generally solitary, occurring in rocky areas and high relief with refuge space, particularly overhangs, caves and crevices (O'Connell and Carlile 1993). Yelloweye are ovoviviparous. Parturition occurs in southeast Alaska between April and July with a peak in May (O'Connell 1987). Fecundity ranges from 1,200,000 to 2,700,000 eggs per season (Hart 1942, O'Connell unpublished data). Yelloweye feed on a variety of prey, primarily fishes (including other rockfishes, herring, and sand lance) as well as caridean shrimp and small crabs. Yelloweye are a K-selected species with late maturation, slow growth, extreme longevity, and low natural mortality. They reach a maximum length of about 91 cm and growth slows considerably after age 30. Approximately 50% are mature at 45 cm and 22 years, natural mortality (M) is estimated to be 0.02, and maximum age reported is 118 years (O'Connell and Fujioka 1991, O'Connell and Funk, 1987).

Fishery

Demersal shelf rockfish are the target of a directed longline fishery and are the primary bycatch species in the longline fishery for Pacific halibut. They recruit into the fishery at about age 18 to 20 at a length between 45 and 50 cm. The commercial fishery grounds are usually areas of rocky bottom between 20 and 100 fm. The directed fishery now occurs between November and March both because of higher winter prices and limitations imposed due to the halibut IFQ regulations.

Relevant Trophic Information:

Yelloweye rockfish eat a large variety of organisms, primarily fishes included small rockfishes, herring and sand lance as well as caridean shrimp and small crabs (Rosenthal et al 1988). They also opportunistically consume lingcod eggs. Young rockfishes are in turn eaten by a variety of predators including lingcod, large rockfish, salmon, and halibut.

Approximate upper size limit of juvenile fish (in cm):

Length at 50% sexual maturity is 45 cm for females and 50 cm for males.

Additional Information Sources

NMFS, Alaska Fisheries Science Center

Habitat and Biological Associations (if known) Narrative

Young juveniles between 2.5 (1 inch) and 10 cm (4 inches) have been observed in areas of high relief (vertical walls, cloud sponges, fjord-like areas) in depths deeper than 15 m (personal communication Jeff Christiansen, The Seattle Aquarium). Subadult (late juveniles) and adult fish are generally solitary, occurring in rocky areas and high relief with refuge spaces particularly overhangs, caves and crevices (O'Connell and Carlile 1993). Not infrequently an adult yelloweye rockfish will cohabitate a cave or refuge space with a tiger rockfish. Habitat specific density data shows an increasing density with increasing habitat complexity: deep water boulder fields consisting of very large boulders have significantly higher densities than other rock habitats (O'Connell and Carlile 1993). Although yelloweye do occur over cobble and sand bottoms, generally this is when foraging and often these areas directly interface with a rock wall or outcrop.

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SPECIES: Yelloweye Rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	na							
Larvae	<6 mo	Copepod	Spring/ Summer	U	N?	U	U	
Early Juveniles	to 10 yrs	U		ICS, MCS, OCS, BAY, IP	D	R, C	U	
Late Juveniles	10-18 yrs	U		ICS, MCS, OCS, BAY, IP	D	R, C	U	
Adults	At least 118 years	Fish, shrimp, crab	Parturition: Apr-Jul	ICS, MCS, OCS, USP, BAY, IP	D	R, C, CB	U	

Other Rockfishes:

Species	Range/Depth	Maximum Age	Trophic	Parturition	Known Habitat
Quillback	Kodiak Island to San Miguel Island, CA To 274 m (commonly 12-76 m)	At least 32 50% SM=30 cm	Main prey = crustaceans, herring, Sandlance	Spring (Mar-Jun)	Juveniles have been observed at the margins of kelp beds, adults occur over rock bottom, or over cobble/sand next to reefs
Copper	Shelikof St to central Baja, CA Shallow to 183 m (commonly to 122 m)	At least 31 years 50% SM=5 yr	Crustaceans Octopi Small fishes	Mar-Jul	Juveniles have been observed near eelgrass beds and in kelp, in areas of mixed sand and rock. Adults are in rocky bays and shallow coastal areas, generally less exposed than the other DSR
Tiger	Kodiak Is and Prince William Sound to Tanner-Cortes Banks, CA From 33 to 183 m	To 116 yrs	Invertebrates, primarily crustaceans	Early spring	Juveniles and adults in rocky areas: most frequently observed in boulder areas, generally under overhangs.
China	Kachemak Bay to San Miguel Island, CA To 128 m	To 72 yrs	Invertebrates, Brittle stars are significant component of diet	Apr-Jun	Juveniles have been observed in shallow kelp beds, adults in rocky reefs and boulder fields. Some indications that adults have a homesite.
Rosethorn	Kodiak Is to Guadalupe Is, Baja, CA To 25 m to 549 m	To 87 yrs Mature 7-10 yrs		Feb-Sept (May)	Observed over rocky habitats and in rock pavement areas with large sponge cover
Canary	Shelikof St to Cape Colnett, Baja, CA To 424 m (commonly to 137 m)	To 75 yrs 50% sm = 9	Macroplankton and small fishes		Occur over rocky and sand/cobble bottoms, often hovering in loose schools over soft bottom near rock outcrops. Schools often associate with schools of yellowtail and silvergrey.

Habitat Description for Thornyhead Rockfish

(Sebastolobus spp.)

Management Plan and Area GOA

Life History and General Distribution

Thornyheads of the northeastern Pacific Ocean are comprised of two species, the shortspine thornyhead (*Sebastolobus alascanus*) and the longspine thornyhead (*S. altivelis*). The longspine thornyhead is not common in the Gulf of Alaska. The shortspine thornyhead is a demersal species which inhabits deep waters from 93 to 1,460 m from the Bering Sea to Baja California. This species is common throughout the Gulf of Alaska, eastern Bering Sea and Aleutian Islands. The population structure of shortspine thornyheads, however, is not well defined. Thornyheads are slow-growing and long-lived with maximum age in excess of 50 years and maximum size greater than 75 cm and 2 kg. Thornyheads spawn buoyant masses of eggs during the late winter and early spring that resemble bilobate “balloons” which float to the surface. Juvenile shortspine thornyheads have a pelagic period of about 14-15 months and settle out at about 22 to 27 mm. Fifty percent of female shortspine thornyheads are sexually mature at about 21 cm and 12-13 years of age.

Fishery

Trawl and longline gear are the primary methods of harvest. The bulk of the fishery occurs in late winter or early spring through the summer. In the past, this species was seldom the target of a directed fishery. Today thornyheads are one of the most valuable of the rockfish species, with most of the domestic harvest exported to Japan. Thornyheads are taken with some frequency in the longline fishery for sablefish and cod and is often part of the bycatch of trawlers concentrating on pollock and Pacific ocean perch.

Relevant Trophic Information

Shortspine thornyheads prey mainly on epibenthic shrimp and fish. Yang (1993, 1996) showed that shrimp were the top prey item for shortspine thornyheads in the Gulf of Alaska; whereas, cottids were the most important prey item in the Aleutian Islands region. Differences in abundance of the main prey between the two areas might be the main reason for the observed diet differences. Predator size might be another reason for the difference since the average shortspine thornyhead in the Aleutian Islands area was larger than that in the Gulf of Alaska (33.4 cm vs 29.7 cm).

Approximate upper size limit of juvenile fish (in cm):

Female shortspine thornyheads appear to be mature at about 21-22 cm.

Additional Information Sources

NMFS, Alaska Fisheries Science Center

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Eggs float in masses of various sizes and shapes. Frequently the masses are bilobed with the lobes 15 cm to 61 cm in length, consisting of hollow conical sheaths containing a single layer of eggs in a gelatinous matrix. The masses are transparent and not readily

observed in the daylight. Eggs are 1.2 to 1.4 mm in diameter with a 0.2 mm oil globule. They move freely in the matrix. Complete hatching time is unknown but is probably more than 10 days.

Larvae: Three day-old larvae are about 3 mm long and apparently float to the surface. It is believed that the larvae remain in the water column for about 14-15 months before settling to the bottom.

Juveniles: Very little information is available regarding the habitats and biological associations of juvenile shortspine thornyheads

Adults: Adults are demersal and can be found at depths ranging from about 90 to 1,500 m. Groundfish species commonly associated with thornyheads include: arrowtooth flounder (*Atheresthes stomias*), Pacific ocean perch (*Sebastes alutus*), sablefish (*Anoplopoma fimbria*), rex sole (*Glyptocephalus zachirus*), Dover sole (*Microstomus pacificus*), shortraker rockfish (*Sebastes borealis*), roughey rockfish (*Sebastes aleutianus*), and grenadiers (family Macrouridae). Two congeneric thornyhead species, the longspine thornyhead (*Sebastolobus altivelis*) and a species common off of Japan, *S. Macrochir*, are infrequently encountered in the Gulf of Alaska.

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SPECIES: Thornyhead Rockfish

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	U	Spawning: Late winter and early spring	U	P	U	U	
Larvae	<15 Months	U	Early spring through summer	U	P	U	U	
Juveniles	> 15 months when settling to bottom occurs (?)	U Shrimp, Amphipods, Mysids, Euphausiids?	U	MCS, OCS, USP	D	M, S, R, SM, CB, MS, G	U	
Adults	U	Shrimp Fish (cottids), Small crabs	Year-round?	MCS, OCS, USP, LSP	D	M, S, R, SM, CB, MS, G	U	

Habitat Description for Atka mackerel

(Pleurogrammus monopterygius)

Management Plan and Area GOA

Life History and General Distribution

Distributed from the Gulf of Alaska to the Kamchatka Peninsula, most abundant along the Aleutians. Adult Atka mackerel occur in large localized aggregations usually at depths less than 200 m and generally over rough, rocky and uneven bottom near areas where tidal currents are swift. Adults are pelagic during much of the year, but migrate annually to moderately shallow waters where they become demersal during spawning. Spawning peaks in June through September, but may occur intermittently throughout the year. Atka mackerel deposit eggs in nests built and guarded by males on rocky substrates or on kelp in shallow water. Eggs hatch in 40-45 days, releasing planktonic larvae which have been found up to 800 km from shore. Little is known of the distribution of young Atka mackerel prior to their appearance in trawl surveys and the fishery at about age 2-3 years. r-traits: young age at maturity (approximately 50% are mature at age 3), fast growth rates, high natural mortality ($M=0.3$) and young average and maximum ages (about 5 and 14 years, respectively). K-selected traits low fecundity (only about 30,000 eggs/female/year, large egg diameters (1-2 mm) and male nest-guarding behavior).

Fishery

Bottom trawls, some pelagic trawling, recruit at about age 3, conducted in the Aleutian Islands and western GOA at depths between about 70-225 m, in trawlable areas on rocky, uneven bottom, along edges, and in lee of submerged hills during periods of high current. Currently, the fishery occurs on reefs west of Kiska Island, south and west of Amchitka Island, in Tanaga Pass and near the Delarof Islands, and south of Seguam and Umnak Islands. Historically fishery occurred east into the GOA as far as Kodiak Island (through the mid-1980s), but is no longer there. Fishery used to be entirely during summer, during spawning season; now occurs throughout the year. Very "clean" fishery; bycatch of other species is minimal.

Relevant Trophic Information

Important food for Steller sea lions in the Aleutian Islands, particularly during summer, and for other marine mammals (minke whales, Dall's porpoise and northern fur seal). Juveniles eaten by thick billed murres and tufted puffins. Main groundfish predators are Pacific halibut, arrowtooth flounder, and Pacific cod.

Approximate upper size limit of juvenile fish (in cm): 35 cm

Additional Information Sources

NMFS, Alaska Fishery Science Center, FOCI program, Sandra Lowe

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Eggs deposited in nests built and guarded by males on rocky substrates or on kelp in shallow water.

Larvae/Juveniles: Planktonic larvae have been found up to 800 km from shore, usually in upper water column (neuston), but little is known of the distribution of Atka mackerel until they are about 2 years old and appear in fishery and surveys.

Adults: Adults occur in localized aggregations usually at depths less than 200 m and generally over rough, rocky and uneven bottom near areas where tidal currents are swift. Adults are semi-demersal/pelagic during much of the year, but migrate annually to moderately shallow waters where the males become demersal during spawning; females move between nesting and offshore feeding areas.

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SPECIES: Atka mackerel

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	40-45 d	NA	summer	IP,ICS	D	GR,R,K	U	develop 3-20°C optimum 9-13°C
Larvae	up to 6 mos	U copepods?	fall-winter	U	U N?	U	U	2-12°C optimum 5-7°C
Juveniles	½-2 yrs of age	U copepods & euphausiids?	all year	U	U	U	U	3-5°C
Adults	3+ yrs of age	copepods euphausiids meso-pelagic fish (myctophids)	spawning (May-Oct) non-spawning (Nov-Apr) tidal/diurnal, year-round?	ICS and MCS, IP MCS and OCS, IP ICS,MCS,O CS,IP	D (males) SD females SD/D all sexes D when currents high/day	GR,R,K	F,E	3-5°C all stages >17 ppt only

Habitat Description for Capelin

(*osmeridae*)

Management Plan and Area GOA

Species Representative:

Capelin (*Mallotus villosus*)

Life History and General Distribution

Capelin is a short-lived marine (neritic), pelagic, filter-feeding schooling fish distributed along the entire coastline of Alaska and the Bering Sea, and south along British Columbia to the Strait of Juan de Fuca; circumpolar. In the N. Pacific, capelin grow to a maximum of 25 cm and 5 years of age. Spawn at ages 2-4 in spring and summer (May-Aug; earlier in south, later in north) when about 11-17 cm on coarse sand, fine gravel beaches, especially in Norton Sound, northern Bristol Bay, along the Alaska Peninsula and near Kodiak. Age at 50% maturity=2 years. Fecundity: 10,000-15,000 eggs per female. Eggs hatch in 2-3 weeks. Most capelin die after spawning. Larvae and juveniles are distributed on inner-mid shelf in summer (rarely found in waters deeper than about 200 m), and juveniles and adults congregate in fall in mid-shelf waters east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands, and north into the Gulf of Anadyr. Distributed along outer shelf and under ice edge in winter. Larvae, juveniles and adults have diurnal vertical migrations following scattering layers - night near surface, at depth during the day. Smelts are captured during trawl surveys, but their patchy distribution both in space and time reduces the validity of biomass estimates.

Fishery

Not a target species in groundfish fisheries of BSAI or GOA, but caught as bycatch (up to several hundred tons per year in the 1990s) principally by yellowfin sole trawl fishery in Kuskokwim and Togiak Bays in spring in BSAI; almost all discarded. Small local coastal fisheries occur in spring and summer.

Relevant Trophic Information

Capelin are important prey for marine birds and mammals as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murres and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance and juvenile pollock (Hunt et al. 1981a; Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise, and fin, sei, humpback, beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987; Wespestad 1987). Smelts are also found in the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot and salmon, throughout the North Pacific Ocean and the Bering Sea (Allen 1987; Yang 1993; Livingston, in prep.).

Approximate upper size limit of juvenile fish (in cm): 13 cm

Additional Information Sources

Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Spawn adhesive eggs (about 1 mm in diameter) on fine gravel or coarse sand (0.5-1 mm grain size) beaches intertidally to depths of up to 10 m in May-July in Alaska (later to the north in Norton Sound). Hatching occurs in 2-3 weeks. Most intense spawning when coastal water temperatures are 5-9°C.

Larvae: After hatching, 4-5 mm larvae remain on the middle-inner shelf in summer; distributed pelagically; centers of distribution are unknown, but have been found in high concentrations north of Unimak Island, in the western GOA, and around Kodiak Island.

Juveniles: In fall, juveniles are distributed pelagically in mid-shelf waters (50-100 m depth; -2-3°C), and have been found in highest concentrations east of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands and north into the Gulf of Anadyr.

Adults: Found in pelagic schools in inner-mid shelf in spring-fall, feed along semi-permanent fronts separating inner, mid, and outer shelf regions (~50 and 100 m). In winter, found in concentrations under ice-edge and along mid-outer shelf.

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SPECIES: Capelin

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	2-3 weeks to hatch	na	May-August	BCH (to 10 m)	D	S,CB		5-9°C peak spawning
Larvae	4-8 months?	Copepods phytoplankton	summer/fall/ winter	ICS-MCS	N,P	U NA?	U	
Juveniles	1.5+ yrs up to age 2	Copepods Euphausiids	all year	ICS-MCS	P	U NA?	U F? Ice edge in winter	
Adults	2 yrs ages 2-4+	Copepods Euphausiids polychaetes small fish	spawning (May-August)	BCH (to 10 m)	D,SD	S,CB		
			non-spawning (Sep-Apr)	ICS-MCS- OCS	P	NA?	F Ice edge in winter	-2 - 3 °C Peak distributions in EBS?

Habitat Description for Eulachon

(*osmeridae*)

Management Plan and Area GOA

Species Representative:

Eulachon, candlefish (*Thaleichthys pacificus*)

Life History and General Distribution

Eulachon is a short-lived anadromous, pelagic schooling fish distributed from the Pribilof Islands in the eastern Bering Sea, throughout the Gulf of Alaska, and south to California. Consistently found pelagically in Shelikof Strait (hydroacoustic surveys in late winter-spring) and between Unimak Island and the Pribilof Islands (bycatch in groundfish trawl fisheries) from the middle shelf to over the slope. In the North Pacific, eulachon grow to a maximum of 23 cm and 5 years of age. Spawn at ages 3-5 in spring and early summer (April-June) when about 14-20 cm in rivers on coarse sandy bottom. Age at 50% maturity=3 years. Fecundity: ~25,000 eggs per female. Eggs adhere to sand grains and other substrates on river bottom. Eggs hatch in 30-40 days in BC at 4-7°C. Most eulachon die after first spawning. Larvae drift out of rivers and develop at sea. Smelts are captured during trawl surveys, but their patchy distribution both in space and time reduces the validity of biomass estimates.

Fishery

Not a target species in groundfish fisheries of BSAI or GOA, but caught as bycatch (up to several hundred tons per year in the 1990s) principally by midwater pollock fisheries in Shelikof Strait (GOA), on the east side of Kodiak (GOA), and between the Pribilof Islands and Unimak Island on the outer continental shelf and slope (EBS); almost all discarded. Small local coastal fisheries occur in spring and summer.

Relevant Trophic Information:

Eulachon may be important prey for marine birds and mammals as well as other fish. Surface feeding (e.g., gulls and kittiwakes), as well as shallow and deep diving piscivorous birds (e.g., murre and puffins) largely consume small schooling fishes such as capelin, eulachon, herring, sand lance and juvenile pollock (Hunt et al. 1981a; Sanger 1983). Both pinnipeds (Steller sea lions, northern fur seals, harbor seals, and ice seals) and cetaceans (such as harbor porpoise, and fin, sei, humpback, beluga whales) feed on smelts, which may provide an important seasonal food source near the ice-edge in winter, and as they assemble nearshore in spring to spawn (Frost and Lowry 1987; Wespestad 1987). Smelts are also found in the diets of some commercially exploited fish species, such as Pacific cod, walleye pollock, arrowtooth flounder, Pacific halibut, sablefish, Greenland turbot and salmon, throughout the North Pacific Ocean and the Bering Sea (Allen 1987; Yang 1993; Livingston, in prep.).

Approximate upper size limit of juvenile fish (in cm): 14 cm

Additional Information Sources

Paul Anderson, NMFS/RACE, Kodiak AK 907-487-4961
Jim Blackburn, ADFG, Kodiak AK 907-486-1861
Mark W. Nelson, NMFS/REFM, Seattle WA 206-526-4699

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Anadromous; return to spawn in spring (May-June) in rivers; demersal eggs adhere to bottom substrate (sand, cobble, etc.). Hatching occurs in 30-40 days.

Larvae: After hatching, 5-7 mm larvae drift out of river and develop pelagically in coastal marine waters; centers of distribution are unknown.

Juveniles and Adults: Distributed pelagically in mid-shelf to upper slope waters (50-1000 m water depth), and have been found in highest concentrations between the Pribilof Islands and Unimak Island on the outer shelf, and in Shelikofeast of the Pribilof Islands, west of St. Matthew and St. Lawrence Islands and north into the Gulf of Anadyr.

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SPECIES: EULACHON (Candlefish)

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	30-40 days	na	April-June	Rivers-FW	D	S (CB?)		4 - 8°C for egg development
Larvae	1-2 months ?	Copepods phytoplankton mysids, larvae	summer/fall	ICS ?	P?	U NA?	U	
Juveniles	2.5+ yrs up to age 3	Copepods Euphausiids	all year	MCS-OCS- USP	P	U NA?	U F?	
Adults	3 yrs ages 3-5+		spawning (May-June)	Rivers-FW	D	S (CB?)		
		Copepods Euphausiids	non-spawning (July-Apr)	MCS-OCS- USP	P	NA?	F?	

Habitat Description for Sculpins

(*cottidae*)

Management Plan and Area GOA

Species Representatives:

Yellow Irish lord (*Hemilepidotus jordani*)
Red Irish lord (*Hemilepidotus hemilepidotus*)
Butterfly sculpin (*Hemilepidotus papilio*)
Bigmouth sculpin (*Hemitripterus bolini*)
Great sculpin (*Myoxocephalus polyacanthocephalus*)
Plain sculpin (*Myoxocephalus jaok*)

Life History and General Distribution:

The Cottidae (sculpins) is a large circumboreal family of demersal fishes inhabiting a wide range of habitats in the north Pacific Ocean and Bering Sea. Most species live in shallow water or in tidepools, but some inhabit the deeper waters (to 1000 m) of the continental shelf and slope. Most species do not attain a large size (generally 10-15 cm), but those that live on the continental shelf and are caught by fisheries can be 30-50 cm; the cabezon is the largest sculpin and can be as long as 100 cm. Most sculpins spawn in the winter. All species lay eggs, but in some genera, fertilization is internal. The female commonly lays demersal eggs amongst rocks where they are guarded by males. Egg incubation duration is unknown; larvae were found across broad areas of the shelf and slope, and were found all year-round, in ichthyoplankton collections from the southeast Bering Sea and Gulf of Alaska. Larvae exhibit diel vertical migration (near surface at night and at depth during the day). Sculpins generally eat small invertebrates (e.g., crabs, barnacles, mussels), but fish are included in the diet of larger species; larvae eat copepods.

Yellow Irish lords: distributed from subtidal areas near shore to the edge of the continental shelf (down to 200 m) throughout the Bering Sea, Aleutian Islands, and eastward into the GOA as far as Sitka, AK; up to 40 cm in length. 12-26 mm larvae collected in spring on the western GOA shelf.

Red Irish lords: distributed from rocky, intertidal areas to about 100 m depth on the middle continental shelf (most shallower than 50 m), from California (Monterey Bay) to Kamchatka; throughout the Bering Sea and Gulf of Alaska; rarely over 30 cm in length. Spawns masses of pink eggs in shallow water or intertidally. Larvae were 7-20 mm long in spring in the western GOA.

Butterfly sculpins: distributed primarily in the western north Pacific and northern Bering Sea, from Hokkaido, Japan, Sea of Okhotsk, Chukchi Sea, to southeast Bering Sea and in Aleutian Islands; depths of 20-250 m, most frequent 50-100 m.

Bigmouth sculpin: distributed in deeper waters offshore, between about 100-300 m in the Bering Sea, Aleutian Islands, and throughout the Gulf of Alaska; up to 70 cm in length.

Great sculpin: distributed from the intertidal to 200 m, but may be most common on sand and muddy/sand bottoms in moderate depths (50-100 m); up to 80 cm in length. Found throughout

the Bering Sea, Aleutian Islands, and Gulf of Alaska, but may be less common east of Prince William Sound. *Myoxocephalus* spp. larvae ranged in length from 9-16 mm in spring ichthyoplankton collections in the western GOA.

Plain sculpin: distributed throughout the Bering Sea and Gulf of Alaska (not common in the Aleutian Islands) from intertidal areas to depths of about 100 m, but most common in shallow waters (<50 m); up to 50 cm in length. *Myoxocephalus* spp. larvae ranged in length from 9-16 mm in spring ichthyoplankton collections in the western GOA.

Fishery

Not a target of groundfish fisheries of BSAI or GOA, but sculpin bycatch (second to skates in weight amongst the Other Species) has ranged from 6,000-11,000 mt per year in the BSAI from 1992-95, and 500-1,400 mt per year in the GOA. Bycatch occurs principally in bottom trawl fisheries for flatfish, Pacific cod and pollock, but also while longlining for Pacific cod; almost all is discarded. Annual sculpin bycatch in the BSAI ranges between 1-4% of annual survey biomass estimates, however little is known of the species distribution of the bycatch.

Relevant Trophic Information

Feed on bottom invertebrates (e.g., crabs, barnacles, mussels and other molluscs); larger species eat fish.

Approximate upper size limit of juvenile fish (in cm): Unknown

Additional Information Sources:

NMFS, Alaska Fisheries Science Center, Sarah Gaichas

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Lay demersal eggs in nests guarded by males; many species in rocky shallow waters near shore.

Larvae: Distributed pelagically and in neuston across broad areas of shelf and slope, but predominantly on inner and middle shelf; have been found all year-round.

Juveniles and Adults: Sculpins are demersal fish, and live in a broad range of habitats from rocky intertidal pools to muddy bottoms of the continental shelf, and rocky, upper slope areas. Most commercial bycatch occurs on middle and outer shelf areas used by bottom trawlers for Pacific cod and flatfish.

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SPECIES: Sculpins

Life Stage	Duration or Age	Diet/Prey	Season-Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	na	winter?	BCH,ICS (MSC-OSC?)	D	R (others?)	U	
Larvae	U	copepods	all year?	ICS-MSC,OCS,US	N,P	na?	U	
Juveniles and Adults	U	bottom invertebrates (crabs, molluscs, barnacles) and small fish	all year	BCH,ICS, MSC, OSC, USP	D	R, S, M, SM	U	

Habitat Description for Sharks

Management Plan and Area GOA

Species Representatives:

Lamnidae:	Salmon shark (<i>Lamna ditropis</i>)
Squalidae:	Sleeper shark (<i>Somniosus pacificus</i>)
	Spiny dogfish (<i>Squalus acanthias</i>)

Life History and General Distribution:

Sharks of the order Squaliformes (which includes the two families Lamnidae and Squalidae) are the higher sharks with five gill slits and two dorsal fins. The Lamnidae are large, ovoviviparous (with small litters, 1-4; embryos nourished by intrauterine cannibalism), widely migrating sharks which are highly aggressive predators (salmon and white sharks). The Lamnidae are partly warm-blooded; the heavy trunk muscles are warmer than water for greater power and efficiency. Salmon sharks are distributed epipelagically along the shelf (can be found in shallow waters) from California through the Gulf of Alaska (where they occur all year and are probably most abundant in our area), the Bering Sea and off Japan. In groundfish fishery and survey data, occur chiefly on outer shelf/upper slope areas in the Bering Sea, but near coast to the outer shelf in the Gulf of Alaska, particularly near Kodiak Island. Not commonly seen in Aleutian Islands. They are believed to eat primarily fish, including salmon, sculpins and gadids, and can be up to 3 m in length.

The Pacific sleeper shark is distributed from California around the Pacific rim to Japan and in the Bering Sea principally on the outer shelf and upper slope (but has been observed nearshore), generally demersal (but also seen near surface). Other members of the Squalidae are ovoviviparous, but fertilization and development of sleeper sharks are not known; adults up to 8 m in length. Voracious, omnivorous predator of flatfish, cephalopods, rockfish, crabs, seals, salmon; may also prey on pinnipeds. In groundfish fishery and survey data, occur chiefly on outer shelf/upper slope areas in the Bering Sea, but near coast to the outer shelf in the Gulf of Alaska, particularly near Kodiak Island.

Spiny dogfish (or closely related species?) are widely distributed through the Atlantic, Pacific and Indian Oceans. In the north Pacific, may be most abundant in the Gulf of Alaska, but also common in the Bering Sea. Pelagic species, found at surface and to depths of 700 m; mostly 200 m or less on shelf and neritic; often found in aggregations. Ovoviviparous, with litter size proportional to size of female, from 2-9; gestation may be 22-24 months. Young are 24-30 cm at birth, with growth initially rapid, then slows dramatically. Maximum adult size is about 1.6 m, and 10 kg; maximum age about 40 years. 50% of females are mature at 94 cm and 29 years old; males, 72 cm and 19 years old. Females give birth in shallow coastal waters, usually in Sept-Jan. Dogfish eat a wide variety of foods, including fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus). Tagging experiments indicate local indigenous populations in some areas and widely migrating groups in others. May move inshore in summer and offshore in winter.

Fishery

Not a target of groundfish fisheries of BSAI or GOA, but shark bycatch has ranged from 300-700 mt per year in the BSAI from 1992-95; 500-1,400 mt per year in the GOA) principally by pelagic trawl fishery for pollock, longline fisheries for Pacific cod and sablefish, and bottom trawl fisheries for pollock, flatfish and cod; almost all discarded. Little is known of shark biomass in BSAI or GOA.

Approximate upper size limit of juvenile fish (in cm): Unknown for salmon sharks and sleeper sharks; for spiny dogfish: 94 cm for females, 72 cm for males.

Additional Information Sources

NMFS, Alaska Fisheries Science Center, Sarah Gaichas

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Salmon sharks and spiny dogfish are ovoviviparous; reproductive strategy of sleeper sharks is not known. Spiny dogfish give birth in shallow coastal waters, while salmon sharks probably offshore and pelagic.

Juveniles and Adults: Spiny dogfish are widely dispersed throughout the water column on shelf in the GOA, and along outer shelf in the EBS; apparently not as commonly found in the Aleutian Islands and not commonly at depths > 200 m.

Salmon sharks found throughout the GOA, but less common in the EBS and AI; epipelagic, primarily over shelf/slope waters in GOA, and outer shelf in EBS.

Sleeper sharks are widely dispersed on shelf/upper slope in the GOA, and along outer shelf/upper slope only in the EBS; generally demersal, and may be less commonly found in the Aleutian Islands.

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SPECIES: SHARKS

Life Stage	Duration or Age	Diet/Prey	Season-Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs and Larvae								
Juveniles and Adults								
Salmon shark	U	fish (salmon, sculpins and gadids)	all year	ICS, MSC, OCS, US in GOA; OCS, US in BSAI	P	NA	U	
Sleeper shark	U	omnivorous; flatfish, cephalopods, rockfish, crabs, seals, salmon, pinnipeds	all year	ICS, MSC, OCS, US in GOA; OCS, US in BSAI	D	U	U	
Spiny dogfish	40 years	fish (smelts, herring, sand lance, and other small schooling fish), crustaceans (crabs, euphausiids, shrimp), and cephalopods (octopus)	all year	ICS, MSC, OCS in GOA; OCS in BSAI give birth ICS in fall/winter?	P	U	U	Euhaline 4-16°C

Habitat Description for Skates (*Rajidae*)

Management Plan and Area GOA

Species Representatives:

Alaska skate (*Bathyraja parmifera*)
Aleutian skate (*Bathyraja aleutica*)
Bering skate (*Bathyraja interrupta*)

Life History and General Distribution:

Skates (*Rajidae*) that occur in the BSAI and GOA are grouped into two genera: *Bathyraja* sp., or soft-nosed species (rostral cartilage slender and snout soft and flexible), and *Raja* sp., or hard-nosed species (rostral cartilage is thick making the snout rigid). Skates are oviparous; fertilization is internal and eggs (one to five or more in each case) are deposited in horny cases for incubation. Adults and juveniles are demersal, and feed on bottom invertebrates and fish. Adult distributions from survey: Alaska skate: mostly 50-200 m on shelf in eastern Bering Sea (EBS) and Aleutian Islands (AI), less common in the Gulf of Alaska (GOA); Aleutian skate: throughout EBS and AI, but less common in GOA, mostly 100-350 m; Bering Skate: throughout EBS and GOA, less common in AI, mostly 100-350 m. Little is known of their habitat requirements for growth or reproduction, nor of any seasonal movements. BSAI skate biomass estimate more than doubled between 1982-96 from bottom trawl survey; may have decreased in GOA and remained stable in the AI in the 1980s.

Fishery

Until 2003, skates were not a target of groundfish fisheries of BSAI or GOA, but caught as bycatch (13,000-17,000 mt per year in the BSAI from 1992-95; 1,000-2,000 mt per year in the GOA) principally by the longline Pacific cod and bottom trawl pollock and flatfish fisheries; almost all discarded. Skate bycatches in the EBS groundfisheries ranged between 1-4% of the annual EBS trawl survey biomass estimates in 1992-95.

Starting in 2003 a directed fishery for skates developed in the GOA centered around Kodiak island. It is prosecuted primarily on longline vessels less than 60 feet long, with some additional targeting by trawlers using large mesh nets. The primary target species appears to be *Raja binoculata*, followed by *Raja rhina*, but this is difficult to determine given that there is almost no observer coverage of the fishery. As of late July 2003 over 2,000 tons of skates had been landed. Market price per pound of skates is comparable to that of cod so the fishery is expected to continue and perhaps expand.

Relevant Trophic Information: Feed on bottom invertebrates (crustaceans, molluscs, and polychaetes) and fish.

Approximate upper size limit of juvenile fish (in cm): Unknown

Additional Information Source

NMFS, Alaska Fisheries Science Center, Sarah Gaichas

Habitat and Biological Associations (if known) Narrative

Egg/Spawning: Deposit eggs in horny cases on shelf and slope.

Juveniles and Adults: After hatching, juveniles probably remain in shelf and slope waters, but distribution is unknown. Adults found across wide areas of shelf and slope; surveys found most skates at depths <500 m in the GOA and EBS, but >500 m in the AI. In the GOA, most skates found between 4-7°C, but data are limited.

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SPECIES: SKATES

Life Stage	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U	na	U	MCS,OCS, USP	D	U	U	
Larvae	na	na	na	na	na	na	na	
Juveniles	U	Invertebrates small fish	all year	MCS,OCS, USP	D	U	U	
Adults	U	Invertebrates small fish	all year	MCS,OCS, USP	D	U	U	

Habitat Description for Squid

(*Cephalopoda, Teuthida*)

Management Plan and Area GOA

Species Representatives:

Gonaditae:

Red or magistrate armhook squid (*Berryteuthis magister*)

Onychoteuthidae:

Boreal clubhook squid (*Onychoteuthis banksii borealjaponicus*)

Giant or robust clubhook squid (*Moroteuthis robusta*);

Sepiolidae:

eastern Pacific bobtail squid (*Rossia pacifica*).

Life History and General Distribution:

Squid are members of the molluscan class Cephalopoda, along with octopus, cuttlefish and nautiloids. In the BSAI and GOA, gonatid and onychoteuthid squids are generally the most common, along with chiroteuthids. All cephalopods are stenohaline, occurring only at salinities > 30 ppt. Fertilization is internal, and development is direct ("larval" stages are only small versions of adults). The eggs of inshore neritic species are often enveloped in a gelatinous matrix attached to rocks, shells or other hard substrates, while the eggs of some offshore oceanic species are extruded as large, sausage-shaped drifting masses. Little is known of the seasonality of reproduction, but most species probably breed in spring-early summer, with eggs hatching during the summer. Most small squid are generally thought to live only 2-3 years, but the giant *Moroteuthis robusta* clearly lives longer.

B. magister is widely distributed in the boreal north Pacific from California, throughout the Bering Sea, to Japan in waters of depth 30-1500 m; adults most often found at mesopelagic depths or near bottom on shelf, rising to the surface at night; juveniles are widely distributed across shelf, slope and abyssal waters in meso- and epipelagic zones, and rise to surface at night. Migrates seasonally, moving northward and inshore in summer, and southward and offshore in winter, particularly in the western north Pacific. Maximum size: females-50 cm mantle length (ML); males-40 cm ML. Spermatophores transferred into the mantle cavity of female, and eggs are laid on the bottom on the upper slope (200-800 m). Fecundity estimated at 10,000 eggs/female. Spawning of eggs occurs in Feb-Mar in Japan, but apparently all year-round in the Bering Sea. Eggs hatch after 1-2 months of incubation; development is direct. Adults are gregarious prior to, and most die after mating.

O. banksii borealjaponicus, an active, epipelagic species, is distributed in the north Pacific from the Sea of Japan, throughout the Aleutian Islands and south to California, but is absent from the Sea of Okhotsk and not common in the Bering Sea. Juveniles can be found over shelf waters at all depths and near shore. Adults apparently prefer the upper layers over slope and abyssal waters; diel migrators and gregarious. Development includes a larval stage; maximum size about 55 cm.

M. robusta, a giant squid, lives near the bottom on the slope, and mesopelagically over abyssal waters; rare on the shelf. It is distributed in all oceans, and is found in the Bering Sea, Aleutian

Islands and Gulf of Alaska. Mantle length can be up to 2.5 m long; with tentacles, at least 7 m, but most are about 2 m long.

R. pacifica is a small (maximum length with tentacles of less than 20 cm) demersal, neritic and shelf, boreal species, distributed from Japan to California in the North Pacific and in the Bering Sea in waters of about 20-300 m depth. Other *Rossia* spp. deposit demersal egg masses.

Fishery:

Not currently a target of groundfish fisheries of BSAI or GOA. A Japanese fishery catching up to 9,000 mt of squid annually existed until the early 1980s for *B. magister* in the Bering Sea and *O. banksii borealjaponicus* in the Aleutian Islands. Since 1990, annual squid bycatch has been about 1,000 mt or less in the BSAI, and between 30-150 mt in the GOA; in the BSAI, almost all squid bycatch is in the midwater pollock fishery near the continental shelf break and slope, while in the GOA, trawl fisheries for rockfish and pollock (again mostly near the edge of the shelf and on the upper slope) catch most of the squid bycatch.

Relevant Trophic Information

The principal prey items of squid are small forage fish pelagic crustaceans (e.g., euphausiids and shrimp), and other cephalopods; cannibalism is not uncommon. After hatching, small planktonic zooplankton (copepods) are eaten. Squid are preyed upon by marine mammals, seabirds, and, to a lesser extent by fish, and occupy an important role in marine food webs worldwide. Perez (1990) estimated that squids comprise over 80% of the diets of sperm whales, bottlenose whales and beaked whales, and about half of the diet of Dall's porpoise in the eastern Bering Sea and Aleutian Islands. Seabirds (e.g., kittiwakes, puffins, murres) on island rookeries close to the shelf break (e.g., Buldir Island, Pribilof Islands) are also known to feed heavily on squid (Hatch et al. 1990; Byrd et al. 1992; Springer 1993). In the Gulf of Alaska, only about 5% or less of the diets of most groundfish consisted of squid (Yang 1993). However, squid play a larger role in the diet of salmon (Livingston and Goiney 1983).

Approximate upper size limit of juvenile fish (in cm):

For *B. magister*, approx. 20 cm ML for males, 25 cm ML for females; both at approximately 1 year of age.

Additional Information Source

NMFS, Alaska Fisheries Science Center, Sarah Gaichas
NMFS, Alaska Fisheries Science Center, Beth Sinclair

Habitat Narrative for *B. magister*:

Egg/Spawning: Eggs are laid on the bottom on the upper slope (200-800 m); incubate for 1-2 months.

Young Juveniles: Distributed epipelagically (top 100 m) from the coast to open ocean.

Old Juveniles and Adults: Distributed mesopelagically (most from 150-500 m) on the shelf (summer only?), but mostly in outer shelf/slope waters (to lesser extent over the open ocean). Migrate to slope waters to mate and spawn demersally.

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SPECIES: *Berryteuthis magister* (red squid)

Life Stage	Duration or Age	Diet/Prey	Season-Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	1-2 months	NA	varies	USP,LSP	D	M,SM,MS	U	
Young juveniles	4-6 months	zooplankton		All shelf, slope, BSN	P,N	NA	UP,F?	
Older Juveniles and Adults	1-2 years (may be up to 4 yrs)	euphausiids, shrimp, small forage fish, and other cephalopods	summer	All shelf, USP,LSP,BSN	SP	U	UP,F?	Euhaline waters, 2-4°C

Habitat Description for Octopus

Management Plan and Area GOA

Species Representatives:

Octopoda: Octopus (*Octopus gilbertianus*; *O. dofleini*)

Vampyromorpha: Pelagic octopus (*Vampyroteuthis infernalis*)

Life History and General Distribution:

Octopus are members of the molluscan class Cephalopoda, along with squid, cuttlefish and nautiloids. In the BSAI and GOA, the most commonly encountered octopods are the shelf demersal species *O. gilbertianus* and *O. dofleini*, and the bathypelagic finned species, *V. infernalis*. Octopods, like other cephalopods are dioecious, with fertilization of eggs (usually within the mantle cavity of the female) requiring transfer of spermatophores during copulation. Octopods probably do not live longer than about 2-4 years, and females of some species (e.g., *O. vulgaris*) die after brooding their eggs on the bottom.

O. gilbertianus - Medium sized octopus (up to 2 m in total length) distributed across the shelf (to 500 m depth) in the eastern and western Bering Sea (where it is the most common octopus), Aleutian Islands, and Gulf of Alaska (endemic to the North Pacific). Little is known of its reproductive or trophic ecology, but eggs laid on the bottom and tended by females. Lives mainly among rocks and stones.

O. dofleini - Giant octopus (up to 10 m in total length, though mostly about 3-5 m) distributed in the southern boreal region from Japan and Korea, through the Aleutian Islands, Gulf Alaska, and south along the Pacific coast of North America to California. Inhabits the sublittoral to upper slope. Egg length 6-8 mm; laid on bottom. Copulation may occur in late fall-winter, but oviposition the following spring; each female lays several hundred eggs.

V. infernalis - Relatively small (up to about 40 cm total length) bathypelagic species, living at depths well below the thermocline; may be most commonly found at 700-1500 m. Found throughout the world's oceans. Eggs are large (3-4 mm in diameter) and are shed singly into the water. Hatched juveniles resemble adults, but with different fin arrangements, which change to the adult form with development. Little is known of their food habits, longevity, or abundance.

Fishery

Not currently a target of groundfish fisheries of BSAI or GOA. Bycatch has ranged between 200-1,000 mt in the BSAI and 40-100 mt in the GOA, chiefly in the pot fishery for Pacific cod and bottom trawl fisheries for cod and flatfish, but sometimes in the pelagic trawl pollock fishery. Directed octopus landings have been less than 8 mt/year for 1988-95. Age/size at 50% recruitment is unknown. Most of the bycatch occurs on the outer continental shelf (100-200 m depth), chiefly north of the Alaskan peninsula from Unimak I. To Port Moller and northwest to the Pribilof Islands; also around Kodiak Island and many of the Aleutian Islands.

Relevant Trophic Information

Octopus are eaten by pinnipeds (principally Steller sea lions, and spotted, bearded, and harbor seals) and a variety of fishes, including Pacific halibut and Pacific cod (Yang 1993). When small, octopods eat planktonic and small benthic crustaceans (mysids, amphipods, copepods). As adults, octopus eat benthic crustaceans (crabs) and molluscs (clams).

Approximate upper size limit of juvenile fish (in cm): Unknown

Additional Information Source

NMFS, Alaska Fisheries Science Center, Sarah Gaichas

Habitat Narrative for *Octopus* spp.:

Egg/Spawning: shelf; eggs laid on bottom, maybe preferentially among rocks and cobble.

Young Juveniles: semi-demersal; widely dispersed on shelf, upper slope

Old Juveniles and Adults: demersal, widely dispersed on shelf and upper slope, preferentially among rocks, cobble, but also on sand/mud.

Literature

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SPECIES: *Octopus dofleini*, *O. gilbertianus*

Life Stage	Duration or Age	Diet/Prey	Season-Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	U (1-2 months?)	NA	spring-summer?	U (IS, MS?)	D	R, G?	U	Euhaline waters
Young juveniles	U	zooplankton	summer-fall	U (IS, MS, OS, USL?)	D,SD	U	U	Euhaline waters
Older Juveniles and Adults	U (2-3 yrs? for <i>O.gilbertianus</i> ; older for <i>O.dofleini</i>)	crustaceans, molluscs	all year	IS, MS, OS, USL	D?	R, G, S, MS	U	Euhaline waters